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MASONRY DAM FOR THE GRANITE SPRINGS RESERVOIR, CHEYENNE WATER-WORKS.*

By A. J. Wiley,† M. Am. Soc. C. E.

The City of Cheyenne, the capital of Wyoming, obtains its water supply from Crow Creek, a tributary of the South Platte River, through a combined gravity and pumping system owned and operated by the city. At a point about six miles from the city a submerged dam intercepts the underflow of the creek, and above the dam a system of filtration galleries beneath the bed of the creek carries the water to a central well. From this well the water is conveyed in a vitrified clay pipe to a covered masonry distributing reservoir located at a sufficient elevation to distribute the water through the city by gravity. A series of lakes is formed on the high ground to the north of the city by filling a number of natural basins from an open canal, heading in Crow Creek below the filtration galleries, and catching the surplus water of the stream. These lakes are filled at the high water stage of the creek and used to supplement the low water period by discharging back into the creek, near the city, upon a second set of filtration galleries from whence the filtered water is conveyed to another masonry reservoir in the lowest part of the city. From this reservoir the water is pumped into the city mains at times of scarcity, and in times of fire, in order to increase the pressure secured by gravity from the upper reservoir. The city has a population of about 15,000. At the season of extreme low water the consumption is about 2,000,000 gallons per 24 hours, of which 1,200,000 gallons comes from the upper filtration galleries and 800,000 through the lower galleries from the lakes.

GRANITE SPRINGS RESERVOIR DAM FOR THE WATER-WORKS OF CHEYENNE, WYO.

The watershed of Crow Creek above the city is approximately 250 sq. miles, but from a large portion of this area the run-off is very slight, and during the summer season the entire flow of the stream is derived from the comparatively small area of mountainous country in which the creek has its sources. The principal run-off takes place in April, May and June, when the accumulated snow of the higher drainage area is being melted by the beginning of summer.

Many small irrigation ditches, mostly for the use of individual ranches, take water from Crow Creek, and in the year 1888 the water was adjudicated under the state irrigation law, and the rights of the 52 claimants defined in the order of their priority of use, the city of Cheyenne securing the first right to the use of 12.48 sec. ft. This would give the city an ample supply, but, unfortunately, it is far more than there is flowing in the stream at the season of lowest flow and greatest use, when the flow at the upper filtration galleries goes as low as 1,200,000 gallons per day, or less than 2 sec. ft. The obvious remedy for this shortage is the storage of flood water, and this had been done on a small scale by the use of the natural lake beds as described above. These, however, were limited in extent, and the loss by evaporation from the shallow reservoirs was very heavy.

About twelve miles above Cheyenne, Crow Creek divides into three branches, the North Fork, the South Fork, and the Middle Fork. The South Fork has a very small watershed and a small run-off. The North Fork and the Middle Fork have about the same area of watershed, but the North Fork drains a comparatively low and flat country with no facilities for storage. The Middle Fork heads in the Continental Divide north of the Sherman Summit on the Union Pacific Railway, and drains a country composed almost entirely of bare granite rocks, or slopes of disintegrated granite, with an altitude ranging from 7,000 to 10,000 ft.

An examination of the storage facilities of the Middle Fork was made for the city by the United States Geological Survey, and it was found that, at what is now known as the Granite Springs reservoir, a dam 90 ft. high would have a capacity of 5,321 acre-feet, or about 1,734,000,000 gallons, with a water surface covering 185 acres. The capacity of the reservoir for different heights is given in Table I. (condensed here.—Ed.):

TABLE I. CAPACITY OF RESERVOIR AT DIFFERENT HEIGHTS.

Gage height	Area, acres	Capacity, Acre-feet	Capacity, Gallons
90	185.15	5,321.35	1,733,972,000
85	164.79	4,446.50	1,448,894,000
80	147.13	3,666.70	1,194,862,000
60	85.55	1,379.60	449,545,000
40	25.03	206.05	67,142,000
20	2.68	11.60	3,780,000

PRECIPITATION.—Table II. gives the precipitation at Cheyenne from 1871 to 1904, inclusive, as determined by the U. S. Weather Bureau.

From this table it will be seen that the average annual precipitation is 13.23 ins. The maximum for any one year was 20.79 ins. in 1896, and the minimum of 5.04 occurred in 1876. The greatest average monthly precipitation is 2.37 ins. for May, and the least is 0.37 ins. for November and December, with 0.38 for January and 0.53 for February, April, June, July and August range from 1.47 to 1.96 ins. per month. The greatest precipitation for any one month was 6.66 ins. for May, 1904, and the months of September, October and November occasionally pass entirely without precipitation.

RUN-OFF.—As practically all the precipitation for December, January, February and March occurs as snow, which all melts in the months of April, May, June and July, it follows that nearly all the run-off is concentrated in these four months.

Table III. shows the run-off measured at the dam site for the year 1903 from observations of the U. S. Geological Survey, except for the months of December, January, February and March, which are assumed as being at the same rate as November.

The table shows a total run-off of 7,344 acre-feet from 27.5 sq. miles of watershed, with a rainfall of 12.25 ins. This run-off is 41% of the precipitation, and 65% of it occurred in April and May, which only contributed 21% of the precipitation. April, May and June gave 79% of the run-off and 32% of the precipitation.

ORGANIZATION.—The decision to supplement the water supply of Cheyenne by storage on the Middle Fork of Crow Creek at the site described above was made in 1902, and immediate steps were taken to put the decision into practical shape. At the inception of the work, Mr. John L. Murray, one of the leading business men of the city, was Mayor, and Mr. M. P. Keefe, a con-

*Slightly condensed from a copy of the author's manuscript report to the City of Cheyenne, Wyo.

†Chief Engineer, Boise, Idaho.

FIG. 2. GENERAL VIEW OF GRANITE SPRINGS DAM AND SPILLWAY.

tractor of wide experience, was Chairman of the Water Committee. During the latter and greater part of the construction, Mr. Keefe was the Mayor and Mr. S. A. Bristol and Mr. R. W. Warren were successively the Chairmen of the Water Committee. From all of these and from Mr. W. D. Pease, City Engineer, the engineers entrusted with the execution of the work received the most cordial cooperation.

In May, 1902, the writer was employed as chief engineer with instructions to design a dam for the lowest possible cost consistent with absolute safety. Plans and specifications were prepared for a masonry dam of gravity section, and a contract for its construction was made with Gaffy & Keefe, of Denver, Colo., on Aug. 21, 1902. Mr. G. W. Zorn was appointed resident engineer and occupied this position throughout the construction of the dam.

PROGRESS OF THE WORK.—The first masonry was laid on April 20, 1903, and when work was stopped for the season, because of cold weather on Nov. 20, 1903, 11,420 cu. yds. of masonry had been laid out of a total of 14,422 yds. Work was resumed on April 11, 1904, and the last masonry was placed in the dam on June 21, 1904. The construction of the spillways and measuring weirs occupied nearly another month, and the work was completed on Aug. 15, 1904.

GENERAL DESCRIPTION.—The dam (Figs. 1 to 3) is constructed throughout of undressed rubble masonry laid in Portland cement mortar. It is curved in plan but of gravity section, the arch form being selected as giving additional stability without requiring more masonry than would have been necessary for a dam straight in plan. The location was indicated within very narrow limits by the topography of the canyon, the most favorable site, both on account of the excellent foundation and of the possibility of constructing a spillway entirely separate from the dam, being at the upper end of the canyon at the lower end of the reservoir basin. At this place the creek flowed on bare granite rock, and from the creek bed the slopes on either side rose at the rate of 2 horizontal to 1 vertical. On the right side the hard rock was exposed for nearly the entire height of the dam, but on the left side the entire slope was covered with disintegrated granite. About 200 ft. east of the left end of the dam, and separated from it by two peaks rising to a height of 30 ft. above its crest, is a natural depression, or saddle, about 85 ft. above the creek bed. In this saddle the spillway was located with its crest 60 ft. above the creek bed.

The dam is constructed on a curve of 300-ft. radius. Its extreme height from foundation to parapet is 96 ft. Its length on the base is 10 ft. and on the top is 410 ft. The thickness on top is 10 ft., and on the base, 56 ft. The parapet wall is

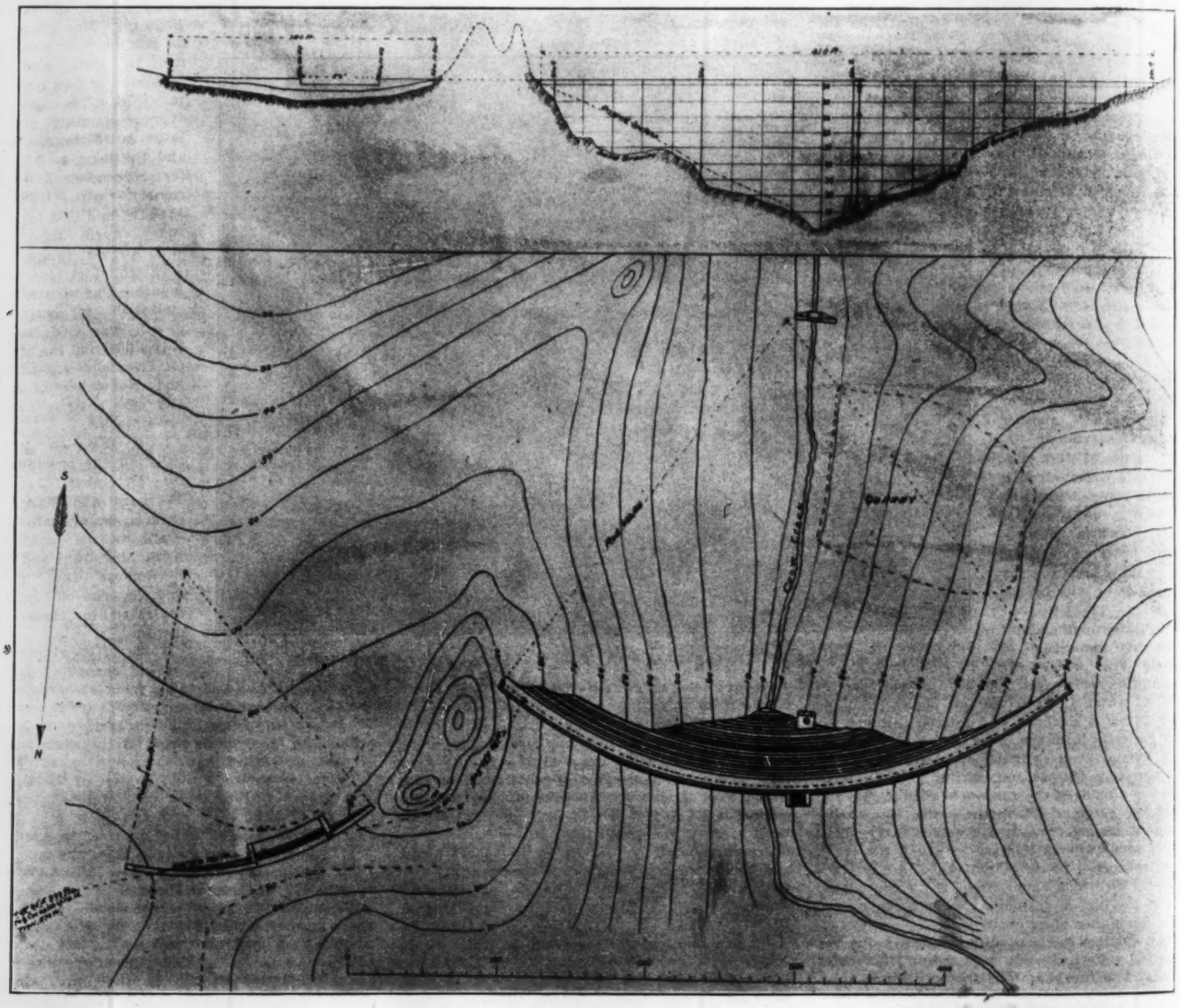


FIG. 3. PLAN AND PROFILE OF DAM.

2 ft. thick and 3 ft. high. The dam contains 14,422 cu. yds. of masonry. In calculating the section of the dam it was assumed that the specific gravity of the granite rubble masonry would be 2.5, corresponding to a weight of 156.25 lbs. per cu. ft. The specific gravity of the rock was found to be 2.83, corresponding to 177 lbs. per cu. ft., and the average specific gravity of the mortar was calculated to be 2.21, corresponding to a weight of 138 lbs. per cu. ft. The estimated weight of the masonry is 165 lbs. per cu. ft., corresponding to a specific gravity of 2.64. The dam was so designed that the lines of pressure corresponded with the limits of the middle third with a specific gravity of 2.5, but as shown by Fig. 4, the line of pressure, reservoir full, with a specific gravity of 2.64, falls 1 ft. inside the middle third at the base.

FOUNDATION.—The entire base of the dam, except that part of the east end which lies more than 50 ft. above the creek bed, is a variety of granite known as gabbro, a dense hard rock, entirely free from seams or cracks and almost devoid of cleavage planes. Above elevation 50 at the north end, the gabbro ceases to rise and is overlaid by a different variety of granite with regular cleavage planes. This granite is soft on the surface, but increases in hardness with depth. At the plane of contact with the underlying gabbro there is no apparent seam, though there is a marked difference in the hardness and texture of the rock. The soft part of this overlying rock was excavated, and in places a depth of nearly 30 ft. was attained before a satisfactory foundation was found. A great part of the gabbro rock had been worn to a smooth vitreous surface which was roughened by shallow shooting, or by rough pointing, previous to laying masonry.

OUTLET.—Water is drawn from the reservoir through a 24-in. cast iron pipe laid on the bed rock 12 ft. above the creek bed. The pipe is 1¼ ins. thick, with bolted flange connections, and has a 24-in. high pressure Renssellaer standard water-works valve at each end. The up-stream valve is protected by a timber screen, and is operated by a hand-wheel with an indicating stand mounted on the crest of the dam, and connecting with the valve by a vertical non-rising stem supported at intervals of 14 ft. by brass boxes set in stones projecting from the face of the dam. The stem is divided to feet by brass graduations, and serves as a gage rod for the reservoir. The up-stream valve is usually kept wide open, the regulation being done by the down-stream valve, which is more accessible. This valve is also operated by a hand-wheel on an indicating stand which is set immediately over the valve. The details of the pipe and valves are shown by Fig. 4.

CONSTRUCTION METHODS AND APPLIANCES.—The dam is constructed throughout of uncoursed rubble masonry laid in Portland cement mortar. The rock used was taken from the ledge upon which the dam is built, the quarry being located on the right bank of the creek about 100 ft. below the dam. The rock was practically devoid of stratification or cleavage, and had to be blown in large masses from an open face 20 to 40 ft. high. Powder was used as sparingly as possible to avoid shattering the rock. For each yard of rock quarried there was used 0.35 lbs. of dynamite and 1.05 lbs. of black powder. The stone used ranged in size from spalls to 4 cu. yds., probably averaging about 2 cu. yds. The largest rock used contained 5 cu yds., and weighed nearly twelve tons, but rocks of over 3 cu. yds. required such great care in handling that

TABLE II. PRECIPITATION AT CHEYENNE, WYO., 1871 TO 1904, INCLUSIVE.

Yr.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	An'l.
'71	.28	0.08	0.11	0.95	2.17	2.25	1.27	0.36	0.74	0.24	0.66	.16	9.27
'72	.02	0.27	.38	1.61	1.99	2.15	3.90	2.05	1.03	.33	.03	.04	13.80
'73	.03	.02	.38	.92	2.41	1.77	1.10	2.07	.36	.70	.17	.08	10.01
'74	.11	.11	.74	.61	1.50	1.34	1.87	.49	.92	1.86	.04	.16	9.27
'75	.42	.06	.23	.50	1.20	.29	4.47	2.12	1.34	.60	.84	.03	12.10
'76	.02	.06	.55	.23	2.50	.10	.79	.26	T	T	.32	.21	5.04
'77	.20	.14	.98	1.11	2.24	1.27	.43	.83	2.02	1.90	.17	.33	11.71
'78	.08	.13	1.16	.19	4.46	1.71	1.43	2.50	.75	.04	T	.19	12.64
'79	.32	.20	.44	1.66	1.30	.07	1.04	1.26	.00	.65	.23	.17	7.34
'80	.20	.09	.06	.17	.44	1.06	1.88	2.33	1.05	.76	.36	.08	8.38
'81	.36	.22	.32	2.32	1.14	1.22	1.40	1.97	1.75	.88	.29	.01	11.88
'82	.14	.05	.06	.46	2.72	1.85	2.30	.23	.35	.31	.06	.10	8.64
'83	.88	.25	.85	2.76	3.68	3.67	1.45	2.18	.90	1.66	.16	.80	19.24
'84	.76	.26	1.59	1.33	4.83	1.50	.60	2.07	1.25	.50	.18	.67	15.54
'85	.16	1.31	.51	3.76	1.33	2.75	1.92	2.14	.69	.28	1.11	.16	16.12
'86	.52	.84	1.36	1.14	.32	1.52	.71	1.61	1.05	.37	....	....	....
'87	....	....	....	2.20	.94	.80	2.71	1.90	1.25	.49	.29	.35	....
'88	.29	.72	2.04	.94	3.74	.56	2.31	1.15	1.66	.30	.59	.21	14.51
'89	.23	.62	.26	1.24	2.85	3.67	1.23	.71	.54	2.58	.56	.16	14.65
'90	.16	.59	.17	3.93	.81	.65	3.64	3.18	T	.76	.47	.11	14.47
'91	2.03	.80	1.61	1.18	4.72	1.84	.82	2.16	2.03	.25	.82	.56	18.97
'92	.99	1.17	.62	1.21	3.46	2.01	.90	.60	.22	1.12	.31	.89	13.50
'93	.08	.87	.78	1.36	1.64	1.33	.69	1.14	.29	.22	.29	.53	9.22
'94	.20	.72	.93	1.64	1.24	1.64	3.25	2.17	1.23	.18	.08	.70	12.98
'95	.29	.30	1.26	1.21	2.73	2.59	2.54	1.69	.39	.95	.63	.18	14.76
'96	.68	.31	2.06	2.08	2.85	1.41	6.35	2.52	2.08	.28	.14	.03	20.79
'97	.27	.57	2.32	.60	3.07	1.60	3.77	1.66	.41	1.63	.68	1.27	17.25
'98	.48	.06	.39	.68	3.72	2.33	1.83	.90	.47	.25	1.58	.36	13.05
'99	1.23	1.63	1.89	.97	1.70	.74	3.28	1.15	.07	1.27	.07	.18	14.18
'00	.15	1.25	.72	7.66	.76	1.01	1.20	.70	2.19	.63	.09	.33	16.09
'01	.13	1.10	1.54	2.97	2.47	1.93	1.34	.83	.75	.31	T	1.62	14.99
'02	.21	.55	2.11	1.49	2.51	1.55	1.49	.53	3.52	.52	.23	1.79	16.50
'03	.21	1.76	1.00	2.10	.46	1.42	.79	1.90	1.04	.34	.79	.09	12.25
'04	.35	.33	.45	1.80	6.66	1.78	2.00	.87	.83	.57	.02	.06	15.72
Means:	.38	.53	.91	1.62	2.37	1.59	1.96	1.48	.99	.67	.37	.37	13.23

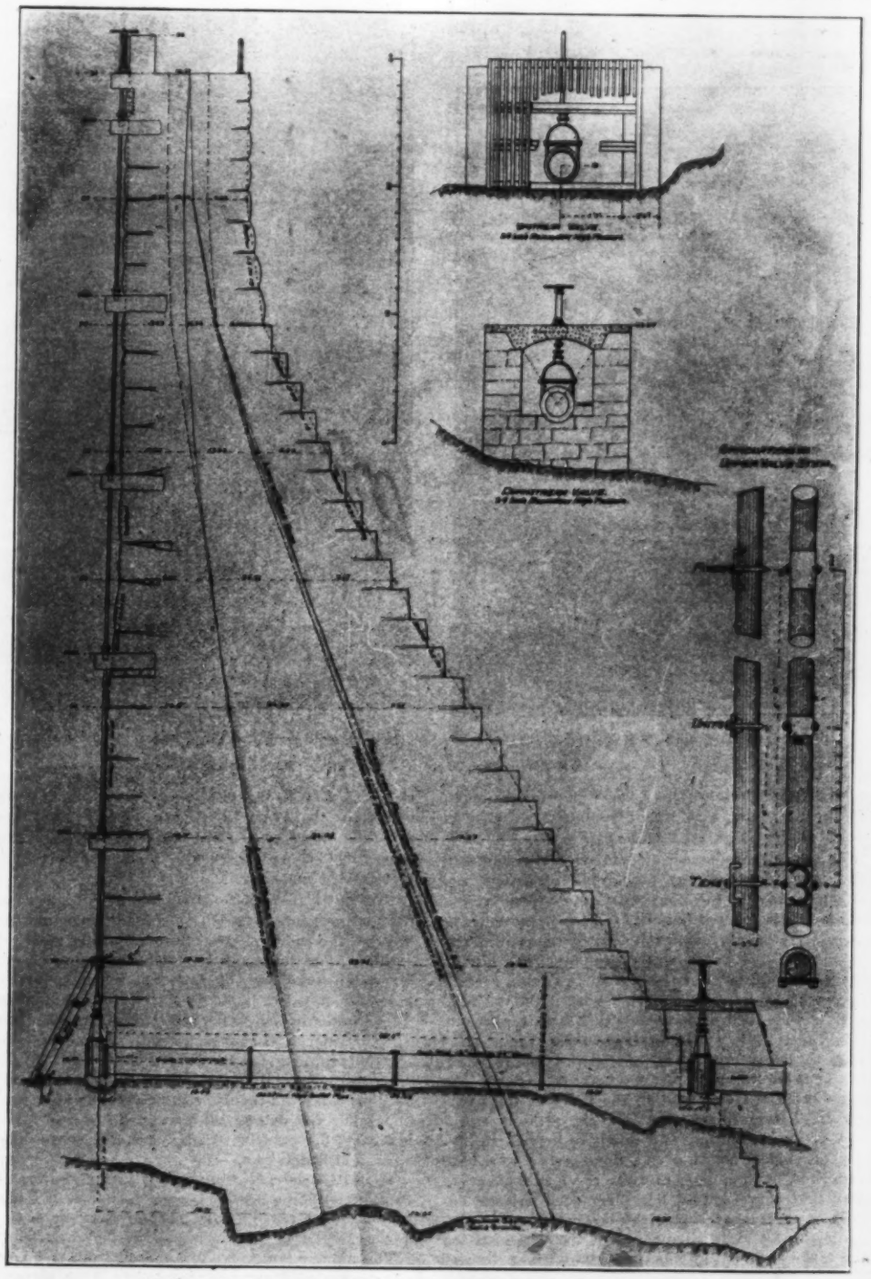


FIG. 4. SECTION AND DETAILS OF DAM.

TABLE III. ESTIMATED MONTHLY DISCHARGE OF MIDDLE FORK OF CROW CREEK FOR 1903.

Month.	Discharge in sec.-ft. Min.	Max.	Mean.	Total Acre-feet.	Gallons.
January	2.7	2.1	2.6	160	52,132,480
February	2.7	2.1	2.6	145	47,245,060
March	2.7	2.1	2.6	160	52,132,480
April	76.0	9.6	38.0	2,280	742,887,840
May	54.0	24.7	40.4	2,484	809,356,752
June	30.1	7.0	17.4	1,035	337,231,980
July	9.6	2.7	5.2	320	104,264,960
August	15.0	1.5	2.8	172	56,042,416
September	3.7	1.1	2.1	125	40,728,500
October	4.8	2.1	2.4	148	48,222,544
November	2.7	2.1	2.6	155	50,503,340
December	2.7	2.1	2.6	160	52,132,480
Total				7,344	2,392,880,832

they were not so profitable as smaller rock. Rocks breaking smaller than 3 cu. yds. were used as they were blasted out of the quarry, and larger masses were split up by plug and feather into roughly rectangular shapes. The best shaped stones were used for face stones, the ordinary rough rocks were used in the body of the dam, and the smaller pieces made the spalls. All drilling was done by hand. The rock was taken from the quarry by a guyed derrick with 40-ft. boom, and loaded upon platform cars. The track was laid upon such a grade that the loaded cars ran alone and the empties were pushed back by hand. The trestle which carried the track was supported by the steps on the down-stream side of the dam, as shown in Figs. 5 and 6. Upon the top of the dam were located two guyed derricks with 40-ft. booms similar to the quarry derrick. Each of the three derricks was operated by a ten-ton hoisting engine located in an engine house near the south end of the dam. The derricks on top of the dam took the rock from the cars on the lower side of the dam and set them in the masonry. They also took the mortar buckets from the cars on the up-stream side of the dam and dumped them where needed on top of the dam.

Spalls were brought upon the dam in skips, holding about a cubic yard each, and kept in the skips until used. The mortar was usually dumped

FIGS. 5 AND 6. VIEWS OF GRANITE SPRINGS DAM UNDER CONSTRUCTION, SHOWING TRACKS USED IN CONVEYING MATERIAL.

in half-yard batches in a convenient depression of the masonry, and was distributed with long-handled, round-pointed shovels.

The up-stream face was laid with the joints in the true plane of the face. No objection was made to having the convexity of a stone project beyond this plane, but no stones with concave faces were permitted in the face of the dam. The upper 20 ft. of the down-stream face was laid in the same manner, but the rest of the down-stream face was laid in rough steps with half the step inside and half outside the theoretical plane of this face. The stone in both these faces were laid to break joint and were well bonded into the body of the dam. In the body of the dam but little attention was paid to the bond of the work, the irregular stones insuring this without effort, but every precaution was taken to insure the filling of voids. To this end the mortar was used very wet, even sloppy, and the chief rule observed was that there should first be placed a large excess of mortar of which the largest possible percentage was to be displaced by rock. In setting the large rock, a bed was prepared with spalls and mortar, and then a considerable excess of mortar was placed on the bed. The rock was then slowly lowered and settled on the bed by working it with bars. The excess mortar would ooze from under the rock which would then float upon an even layer of mortar, filling all the spaces under it. During this operation the inspector, either standing upon the rock or having his hand upon it, can tell if the rock is riding or rocking, and, if necessary, has the rock raised and the bed readjusted. The large rock were set as close as possible to each other without being in contact, the intervening spaces being filled with mortar and spalls. In this work the masons were not permitted to sandwich the spalls between layers of mortar, but were required to first fill the space with wet mortar in which the spalls were submerged, displacing as much as possible of the mortar. While it was the intention to have the masonry brought up in horizontal benches extending the full length of the dam, the exigencies of the work prevented this and the middle portion of the dam was completed first, stepping off toward each end, as shown in the photographs.

PROPORTIONS OF ROCK AND MORTAR.—The total contents of the dam are 14,422 cu. yds., of which 35.2%, or 5,008 cu. yds., are mortar and 64.8%, or 9,414 cu yds., are rock. The total amount of cement used was 35,375 sacks, or 8,843.75 bbls., which gives 0.613-bbl. of cement to 1 cu. yd. of masonry.

RATE OF LAYING MASONRY.—The average rate of progress was 60 cu. yds. of masonry per day of ten hours. The best monthly rate was 2,370 cu. yds. during July, 1903, averaging 83 yds. for a ten-hour day, or 41.5 yds. of masonry per ten-hour day for a single derrick, including the time lost in moving and resetting derricks. During this month the average daily force employed was as follows: In the quarry, 21.3 men, 1⅛ engine runners, and one derrick; in screening and hauling sand, 3.2 teams with drivers, and 3.2 men; in mixing and delivering mortar, 3 men; in laying masonry, 3.5 masons, 6.5 helpers, 2⅞ engine runners, and 2 derricks.

MORTARS.—The face stones and those laid in contact with the bed-rock were laid in 3 to 1 mortar, and all the interior of the dam in 4 to 1 mortar.

The mortar was mixed in a Smith mixer having a capacity of 6 cu. yds. per hour. This mixer is of the revolving drum type, driven by a direct connected 6-HP. engine, and proved [illegible] reliable and efficient mixer. The sand [illegible] cement were placed in hoppers discharging [illegible] into the mixer, and the mixer was discharged by the operator into a steel bucket holding [illegible] cu. ft. The mortar was mixed in batches of [illegible] cu. yd. each, first dry and then with approximately 20% of water. The mixing plant was located on the up-stream side near the west end of the dam. The mortar track was carried by a trestle built against the up-stream face and extended entirely across the canyon at an elevation of [illegible] above the creek bed, or 50 ft. below the crest. Two men were required to supply sand and cement to the mixer, and one man attended to the mixing and delivered the mortar at a point on the mortar track where it could be reached by one of the derricks on the dam.

SAND.—The sand was obtained from shallow deposits in dry stream beds, and hauled in wagons an average distance of half a mile to the dam site. It was passed through slotted screens with ⅜-in. openings and used without washing. The voids in the sand were determined by depositing it slowly in a measured depth of water in a cylindrical vessel. After compacting the sand by light blows upon the sides of the vessel the depth of the sand was measured and the depth of the water above the sand. The difference between this latter and the original depth of the water was taken to represent the voids, and divided by the depth of sand to determine the percentage of voids. The sand used in making tests was taken from the stock at the mixer and was always slightly damp. The result of 25 tests taken at intervals throughout the work gave an average of 23.4% voids, with a minimum of 17% and a maximum of 25%. Twenty-eight per cent. of the sand passed a No. 20 sieve, and this portion contained 33% voids.

CEMENT AND MORTAR TESTS.—Alpha cement was used exclusively on the work. It was shipped in canvas sacks and a test sample was taken from every twentieth sack, or fifth barrel, as it was unloaded from the car. A standard pat on a glass plate was made from each sample; then all the samples from a carload were mixed and tested for fineness, and for tensile strength, neat, and mixed with three volumes of sand. All the standard pats were allowed to set 24 hours under a damp cloth, then half were put in cold water which was brought to the boiling point and kept there for 6 hours. The remaining half were kept in cold water for 28 days. In the tests for soundness, pats occasionally blistered or scaled slightly and sometimes came loose from the plate, but never showed the slightest evidence of distortion. The setting tests were made on the pats used for determining soundness, and showed that the average time of initial set was 45 minutes, varying from 30 minutes to one hour, while the final set always took place within 10 hours. The average of fineness was 93% through the hundred-mesh sieve. In the tensile tests, 12 standard briquettes of neat cement, and 12 of one volume of cement to 3 sand, were made from the mixed samples from each car. The aim in making these tests was to get results fairly comparable to those obtained in the construction, and the cement and mortar were mixed as wet as they could be handled. Daily tests were also made of the mortar used in the masonry by taking samples directly from the batches delivered on the dam. These tests were all made by the same man, the foreman on the work, and without effort to get specially high results. The briquettes were allowed to set 24 hours in damp air, then placed in water, and sets of three were broken in 7 days, 28 days, and 90 days. The results of these tests show that for neat cement the average tensile strength per square inch for 7 days, 28 days, and 90 days, respectively, were 654, 792, and 806 lbs. For 1 to 3 hand-mixed mortar the results were respectively 235, 312 and 345 lbs., and for 1 to 4 machine mixed the results were 226, 306, and 361 lbs. In obtaining these results a total of 1,344 briquettes were broken; 324 each for neat cement and 1 to 3 mortar, and 696 for the 1 to 4 mortar.

THE SPILLWAY.—The spillway is located in a depression, or saddle, 200 ft. northeast of the

dam (see Figs. 2 and 3), and the discharge from the spillway enters the creek 500 ft. below the dam. The saddle is 180 ft. long and is closed by a wall whose crest is at the same elevation as the parapet of the dam. The spillway section is 52 ft. long and 3 ft. lower than the parapet. Its discharge capacity is approximately 900 sec. ft., or twelve times the observed maximum discharge of the stream, and equal to a run-off of 33 sec.-ft. per sq. mile of watershed. The spillway is built upon a curve of 200 ft. radius. The foundation of the face wall was made by cutting a trench 4 ft. wide in the soft granite of the foundation to a depth of from 3 to 6 ft. where a fairly firm rock was encountered. This trench was filled with wet concrete with a large percentage of one and two-man rock imbedded. Above the surface rubble masonry was used. In the spillway section the masonry was 4 ft. wide on top with a batter of 9 ins. to 1 ft. on the down-stream side to the elevation of the natural surface, where it terminates in an apron formed by excavating 12 ins. of the soft granite and replacing it with an equal depth of concrete. The apron is strengthened by two parallel ribs of concrete, each 2 ft. square, in trenches cut beneath the apron, one at its up-stream end and the other at its down-stream end.

MEASURING WEIRS.—Two weirs are provided, one near the upper end of the reservoir and the other 300 ft. below the dam. The weirs are identical in construction and dimensions (see Fig 7). They are built of rubble masonry on bed rock, with angle-iron crests. The weirs are of the trapezoidal, or Cippoletti, type and are 6 ft. long on the crest. They are provided with sluicing valves and permanent gages.

CLEARING RESERVOIR SITE.—The whole area of the water surface is 185 acres, and the contract required that all vegetable matter should be cut down within 6 ins. of the ground. The greater part of the area required no clearing, but bordering the creek and most of its branches was a dense growth of heavy brush and small trees, while on some of the area there were scattering pine trees.

CONTRACT PRICES.

MASONRY.—The contract price on the masonry in the dam, including everything except cement, which was furnished at the dam site by the city, was $3.85 per cu. yd.

EXCAVATION. — Excavation included any material that could be handled by pick and shovel. All excavation of harder material, and all the preparation of the bed rock was done by force account. The contract price on excavation was 80c. per cu. yd.

SPILLWAY AND WEIRS.—The spillway and measuring weirs were let under a separate contract at $4.50 per cu. yd. for concrete, and $7 per cu. yd. for rubble masonry, including excavation.

HAULING.—The hauling of cement and other material from the nearest railway point, a distance of eight miles, was let at 12.5 cts. per 100 lbs.

CLEARING.—The clearing of the reservoir site was let for the lump sum of $994.

ESTIMATED COSTS.

The following estimate is submitted as an approximation of the actual cost of the work to the contractor. In this estimate it is assumed that the depreciation upon the plant in the two seasons' use was 50% of its original cost. A large part of the fuel consumed by the plant was obtained in clearing the reservoir, but in making up the estimate this was not taken into consideration, and the cost of the power was estimated upon the basis of the consumption of 5 pounds of coal per horse-power hour of actual working time for the nominal horse-power of the engines, with coal at $6 per ton delivered:

Cost of Masonry in Dam.		
Mortar.		
Sand, Labor of men and teams	$5,496.58	
Blacksmithing	651.00	
General expense	930.00	
5,008 cu. yds. sand at $1.41	7,077.58	
Mixing and Delivery—		
Labor	1,488.50	
Power	220.00	
Int. & depreciation on plant	620.00	
General expense	270.00	
5,008 cu. yds. mixing and delivering at $0.52	2,598.50	
5,008 cu. yds. mortar at $1.93		$9,676.08
Quarrying and Delivering Rock.		
Common labor	9,987.50	
Engine runners	1,314.00	
Fuel (estimated)	730.00	
Blacksmithing	1,225.00	
Steel	389.40	
Explosives	1,428.06	
Int. & depreciation on plant	1,644.00	
General expense	1,734.64	
9,414 cu. yds. rock at $1.96		$18,452.60
Laying Masonry.		
Labor masons and helpers	7,180.11	
Engine runners	2,628.79	
Fuel (estimated)	1,460.00	
Blacksmithing	341.00	
Interest and depreciation on plant	3,100.00	
General expense	1,308.00	
Laying 14,422 cu. yds. masonry, at $1.11		$16,017.90
Cost of Masonry in Dam:		
9,414 cu. yds. of rock delivered, at $1.96	18,452.60	
5,008 " " " mortar, delivered, at $1.93	9,676.08	
14,422 " " " masonry, laying, at $1.11	16,017.90	
14,422 " " " not including cement, at $3.06	44,146.58	
8,844 bbls. of cement, at $3.58	31,665.38	
14,422 cu. yds. masonry, including cement, at $5.25		$75,811.96
Cost per Cu. Yd., in terms of masonry.		Cu. yd. masonry.
0.652 cu. yds. rock, at $1.96		1.28
0.348 " " mortar, at $1.93		0.67
1.00 " " laying, at $1.11		1.11
1 cu. yd. masonry, not including cement		3.06
0.613 bbls. cement, at $3.58		2.19
Total cost per yd., including cement		$5.25
Clearing Reservoir Site:		
Common labor	$640.72	
Blacksmithing	82.72	
General expense	116.00	
Total	839.44	
Excavating 1,447 cu. yds. from base of dam:		
Common labor	1,147.86	
Blacksmithing	110.00	
General expense	208.00	
Total		$1,465.86
Cost of Labor on Spillway:		
Common labor	374.00	
Blacksmithing	81.00	
Masons	94.00	
Teams	202.00	
General expense	200.00	
Total	$951.00	
Cost of Labor on Measuring Weirs:		
Common labor	92.00	
Masons	70.00	
Teams	40.00	
General expense	25.00	
Total	$227.00	

COST OF WORK TO THE CITY.

The following statement shows the entire cost of the work to the city, including right of way, engineering, and administration, and the material used in construction:

Entire Cost of Work to the City:			
Right of way and water rights	$3,480.36		
Clearing of reservoir site	994.00		
Cost of reservoir site			$4,474.36
Buildings	958.96		
Excavating 1,447 cu. yds. foundation, 80 cts.	1,157.60		
Excavating and preparing foundations	2,670.52		
Outlet pipe and valves furnished and laid	1,650.69		
8,844 bbls. cement, at $3.58	31,665.32		
14,422.16 cu. yds. masonry, at $3.85	55,525.32		
Railing on dam crest, 386 lin. ft., at 80 cts.	308.40		
Engineering, superintendence and general expense	7,794.33		
Total cost of dam			101,731.20
190.47 cu. yds. concrete in spillway, at $4.50	857.11		
129.62 cu. yds. rubble in spillway, at $7.00	907.34		
196.7 bbls. cement in spillway, at $3.58	704.16		
Total cost of spillway			2,468.61
49.76 cu. yds. rubble in weirs, at $7.00	348.32		
37.8 bbls. cement, at $3.58	135.29		
Valves and crests	36.72		
Total cost of two weirs			520.33
Total cost of reservoir			$109,194.50

TEMPERATURE EFFECTS.—During the past winter when the temperature was below the zero point, a barely perceptible crack appeared near Station 3, about 100 ft. from the west end of the dam, where it is about 30 ft. high. This crack extended entirely around the section in a generally vertical plane following the joints of the masonry except in one place where it went half way through a rock. There are no other indications of temperature effects, and with the warmer weather the crack has entirely closed.

SEEPAGE.—With each rise in the reservoir there is some sweating of the down-stream face which stops when the water level ceases to rise for about 30 days. The amount of this seepage is about equal to the evaporation from the down-stream face on a hot day, when it practically disappears.

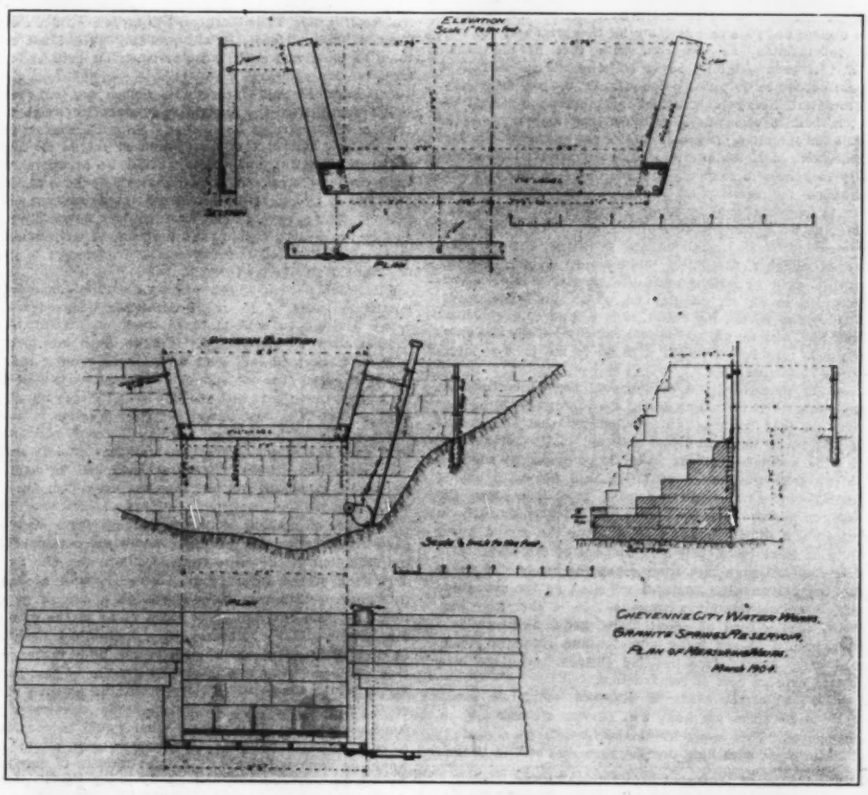


FIG. 7. DETAILS OF TRAPEZOIDAL OR CIPPOLETTI WEIRS, GRANITE SPRINGS DAM, CHEYENNE WATER-WORKS.

LIGHT ELECTRIC RAILWAYS.*

By James R. Cravath.†

Although the building of interurban electric railways has been carried on very actively in the Central States during the last six years, a general survey of the situation shows that the territory served by such roads is rather limited, especially in states west of Indiana. The typical interurban electric railway of the Central States costs from $20,000 to $25,000 per mile of single track. The building of such roads has therefore been generally confined to such places as in the opinion of the builders have sufficient population and resources to yield an annual gross revenue which will leave from $1,200 to $1,500 per track mile to pay interest on the investment after paying operating expenses, maintenance and depreciation. Without going into details, it can be said in a general way that a gross revenue of $3,000 to $4,000 per track mile per year must be earned at the start on a most economically constructed interurban road of the ordinary type, if it is to be a financial success.

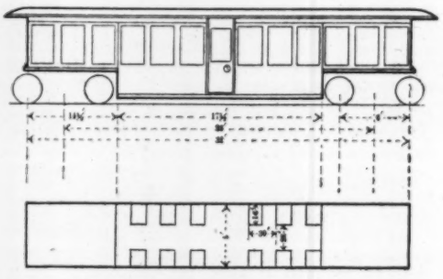
It has for some time been apparent to engineers that have had to advise regarding numerous proposed interurban electric roads in certain states (of which Illinois and Iowa are the most notable examples) that there is need for a class of electric railway that does not require the heavy investment needed to build the typical interurban road of to-day. In other words, there are scores of places that would not yield an interurban road a gross revenue of $3,000 per track mile per year, and there is little prospect that they ever will; yet half or two-thirds that income would be certain and continuous. On account of the numerous opportunities for roads of a cheaper class in our rich agricultural states, which have comparatively few large manufacturing towns, many engineers have looked forward with much hope to the single-phase alternating-current railway motor as making possible a considerable saving in the cost of construction and operation of these roads. A careful review of recent estimates on cost of construction made by various engineers does not reveal any great possible reduction in first cost by the use of the single-phase electric motor as long as present standards of heavy track construction, heavy rolling stock, and high speeds are adhered to.

It is the purpose of this paper to consider whether it is not feasible to work out a new type of light electric railway construction which will involve only about one-third the cost of the typical high-speed interurban road with which we are familiar, which can prosper on a much smaller revenue, and yet fulfil all the transportation requirements of many rural communities. The advent of the single-phase railway motor at least makes such an undertaking appear more promising of success now than in the past.

The first thing to be done in planning such a road is to dismiss the idea of using cars of the weight and operated at the speed required in interurban service, for it would be useless to figure on any material cheapening of the cost of construction, as compared with that of interurban roads, if cars weighing 25 to 30 tons are to be run at speeds of 40 to 50 miles per hour. Of course, first-class, substantial, heavy construction is absolutely essential for interurban service where such construction is to be the basis for operation of cars of the weight and at speeds just mentioned. But the question naturally arises: Is it necessary to adhere to such high standards of service and construction for serving all kinds of communities? Why should hamlets and farming townships in Illinois and Iowa, with populations of 100 to 1,000, be entirely denied electric railway transportation facilities because they cannot support first-class, high-speed, electric railway service, such as now connect the closely situated manufacturing towns of Indiana and Ohio? In other words, is there any reason for establishing a kind of engineering dead-line, and saying no electric railway outside the cities is worth considering unless it is up to the present interurban standards?

As the character of a road should depend entirely on the character of its rolling stock, consideration will be first given to that feature. It is suggested that on a light electric rural and interurban railway, small double-truck cars for a track of about 28-in. gage might be adopted. Narrow-gage railways have fallen into disrepute among railway engineers, and with good reason, because the ordinary narrow-gage road does not differ sufficiently in cost from a standard-gage road to make the saving worth while in most cases, and also because of the inability to take standard-gage cars from connecting roads. If we go into the narrow-gage business we must go far enough to gain some substantial advantage. It is therefore suggested that a road of about 28-in. gage, although at a disadvantage in not being able to take standard steam-road cars, nevertheless has the decided advantage of a greatly reduced cost of construction.

On a road of the character proposed, maximum speeds of 15 to 20 miles per hour will answer all practical requirements. This speed should be feasible on a roadway of 28-in. gage, with light double-truck cars of 8 to 10 tons' weight. A suggestion as to a suitable form of car construction for such a road, with dimensions, is presented in the accompanying outline drawing. As 28 ins. is about one-half standard gage, no doubt cars of one-half the width of standard-gage cars could be used with safety. This would permit a passenger car of 5-ft. width. Such car, if equipped with cross-seats, would be of sufficient width for a single seat of 16 to 18-in. width on each side of an aisle 24 to 28 ins. wide. Longitudinal seats could be used if preferred. It would not be possible to use the regular plan of placing motor-trucks under the car, be-



Outline of Car Suggested for Light Rural Electric Railway of 28-ins. Gage.

cause, in order to keep the center of gravity of the car low enough for safety on the narrow gage, wheels of 16 to 18-in. diameter would have to be used, and it would be impossible to place motors of sufficient capacity on trucks equipped with such wheels. The motor-trucks in this case should therefore be equipped with 30 to 33-in. wheels, which would give abundant room for motors of sufficient capacity to propel the light cars proposed. The car floor is made higher at the ends over the motor-trucks than under the balance of the car. If a motor-truck were placed only under one end of the car the trail-truck could have small wheels and be arranged in the common manner.

By the arrangement shown the center of gravity will be low, and it leaves a compartment at one or both ends of the car above the motor-trucks, in which can be installed the various electrical appliances that are usually under the car but which cannot be so placed when the car body is hung as low as it is in this case. These compartments can also be occupied by the motorman and used for baggage. The car body can be supported by I-beams or channels in the sides of the car just below the windows, and these beams can also support the side sills of the passenger compartment by means of tie rods and struts. The length of the car may vary considerably, but for very light traffic a car 18 ft. long is suggested. This will seat comfortably 12 passengers. Equipped with a motor-truck at one end only, it will probably weight not more than 10 tons, and with a motor-truck on both ends, 12 tons.

It is assumed that single-phase motors are to be used, which would cause the electrical equipment to weigh more than a direct-current equipment. No such narrow-gage, single-phase motors have been produced yet, as far as the writer knows, but undoubtedly could be produced were there need for them. Motor cars, such as suggested, could haul one or two light freight cars on roads without heavy grades. For a road of this kind trailers would probably best serve to carry freight; and they should be designed so as to allow the freight to be readily transferred to grain elevators or steam road freight cars.

With double-truck motor cars of the type suggested, a maximum speed of 15 or 20 miles per hour should be safely possible on a 28-in. gage track with standard T-rails of about 30 lbs. per yd. It costs much less to build a 28-in. gage road laid with 30-lb. rails than a road of standard gage. The tonnage of steel required is half that of a road equipped with 60-lb. rails, these being the lightest that it is now considered good practice to use in interurban electric railway work. The cost per ton of light rails is also about 25% less than that of rails weighing more than 40 lbs. The ties used can be half the standard 8-ft. length and less than the usual 6-in. by 8-in. cross-section.

The cost of grading would be reduced from standard-gage construction for the two following reasons: first, the reduction of the cross-section of cuts and fills by the narrowing of the embankment; secondly, with a road of this kind operating at slow speeds on a narrow gage it would be good engineering to avoid many of the cuts and fills that would be necessary on a high-speed road, and to pick a location which goes round hills rather than through them. The rolling prairie country of the Central States would almost invariably permit the location of the route of such a light railway so as to be almost free from all heavy grading work. What would be considered a very crooked route for a standard-gage steam road would be unobjectionable on a light railway of this kind. By laying out the road so as to avoid heavy grading work, the expense of bridges and trestles would also be reduced to a minimum. In crossing large streams of course approaches and bridges must be built which are out of the way of floods, but large streams with the exception and probably the majority of light railway of this class would not cross any large streams on a highway.

The next question is that of ballast. On many branch steam lines and some interurban electric lines are still operating without ballast it would hardly be wise to invest much money in ballast for a light railway of this kind. Ballast is desirable, to be sure, but in this case the expense would hardly be justified.

The overhead trolley construction should be simple in character, since it will have but light traffic passing under it. By using single-phase, alternating current motors with a trolley pressure of 3,000 to 4,000 volts, feeders will not be needed to supplement the trolley. A rural road 20 miles long with power supply from one end. The trolley wire itself can be No. 0 wire. The poles will therefore need to be heavy enough to support the trolley wire bracket only. It is assumed that the ordinary construction would be used with the trolley wire supported at frequent intervals by a steel catenary, the catenary resting in turn upon center-bearing, high-pressure insulators. Instead of a costly iron bracket for supporting the trolley, a bracket consisting of a 5-ft. wood cross-arm, supported from above by a tie-rod and bolted to the pole at one end, would answer the purpose.

In most cases power could be purchased from a light and power company at the principal terminus of a line, thus keeping the cost of power within reasonable limits as the amount of power required would not justify a separate power house. It is assumed that the railway company would furnish a generator, this generator to be placed in the lighting company's station. The balance of the power investment to be made by the lighting company.

The following estimates are on the cost per mile of a railway built according to the foregoing ideas; these estimates are of course conjectural, as no such road has ever been built. The figures are based on cost of present railway construction, assuming all the supplies and rolling stock to be standard.

COST OF ROAD AND EQUIPMENT PER MILE.

Track and Grading.	
Right of way donated.	
Grading averaging 7,000 cu. yds. per mile at 18 cts. per cu. yd.	$1,240
30-lb. T-rail at $33 per ton, 52.8 tons, 30-ft. lengths	1,742
352 rail-joints at 75 cts. each	264
2,640 ties, 4 ins. by 6 ins. by 4 ft., at 20 cts. each	528
30 kegs spikes at $3	90
560 bonds at 30 cts. each, in place	168
Labor, laying track	300
Highway crossings	25
Fencing (20 miles)	150
Track total	$4,467
General Roadway Items for 15-Mile Road.	
Culverts, etc.	1,500
Bridges	1,000
Special work	2,000
	$4,500
Per mile	300
Overhead Line per Mile.	
48 poles (25-ft.) at $4	$192
Wood brackets (cross-arm size) 3.5 ins. by 4.5 ins. by 60 ins., at 50 cts.	24
48 high-pressure insulators at 15 cts.	8
5 280 ft. No. 0 trolley wire at 15 cts. per lb.	253
6,280 ft. 0.25-in. steel stranded catenary at 65 cts. per ft.	34
528 clips and catenary attachments at 20 cts.	106
Miscellaneous overhead supplies	50
Labor on trolley and catenary	150
48 cross-arm tie-supports at 15 cts.	7
Telephone wire, 2 miles, No. 8	30
Telephone insulators and brackets	10
Labor on telephone line	25
	$889
Rolling Stock, Buildings, etc., for 15-Mile Line.	
3 passenger motor cars at $2,500	$7,500
2 passenger trailers at $750	1,500
1 freight motor car	2,200
15 miscellaneous freight cars at $300	4,500
Car house and repair shop	2,000
100-KW. generator capacity in lighting station	2,000
Miscellaneous engineering and superintendence	15,000
Total for 15 miles	$34,700
Per track mile	$2,313
Recapitulation Cost per Track Mile.	
Track and roadbed	4,467
General roadway items	300
Overhead work	889
Rolling stock, buildings and miscellaneous	2,313
Total per mile of track	7,969

The estimates are believed to be fairly liberal for the class of construction proposed. The total amounts to about $7,900 per mile of track, or a little over one-third of the cost of a standard-gage high-speed road.

The next question to determine is whether a road of this kind is capable of earning enough to pay interest on the investment. Assume the road to be 15 miles long. A good passenger and freight service for a rural community could be given by a daily schedule calling for the equivalent of 15 round-trips of trains consisting of motor cars, hauling freight cars whenever necessary. On a 15-mile road this would mean 450 train-miles per day, or say 135,000 train-miles per year, allowing for some reduction from foregoing schedule during the winter.

*From a paper presented before the Chicago Branch of the American Institute of Electrical Engineers, May 23, 1905.

†Western Editor "Street Railway Journal," Chicago, Ill.

The following is believed to be a fair estimate of the ordinary operating expenses per train-mile of such a road:

Power per train mile, one kw.-hr. at 3 cts. (purchased)	$0.03
Motormen's wages	0.025
Repairs and maintenance on rolling stock	0.005
Repairs and maintenance on track and overhead line	0.01
General expenses	0.015
	$0.085
132,500 train miles per year at $0.085	$11,475
Cost of operation per track mile ($11,475 ÷ 15 miles)	765
Interest at 6% on $7,900 per mile cost construction	474
Interest and operating expenses per track mile	$1,239

Obviously, there are plenty of locations where a road could easily earn this, and in addition enough to cover depreciation. In these locations standard-gage high-speed roads would be prohibited by financial considerations.

Without doubt difficulties stand in the way of the construction of the first roads of this class that may be built. One of the most serious obstacles is that no cars, motors, trucks, or overhead work suitable for such a road are now being manufactured; and before such roads can be built these must be developed, either by the manufacturers or by the prospective user. It is not to be expected that the manufacturer of light electric railway apparatus will be attempted until there is a wide enough interest in and demand for railways of this kind to induce manufacturing companies to develop and market suitable equipments.

Considering better railway transportation as one solution of the good roads problem in the middle west, and the number of places demanding light electric railways, it is important that the attention of the public, of electric railway engineers, and of the manufacturers of electric railway apparatus, be centered on the light electric railway problem. From the manufacturing standpoint it opens an immense field for this kind of railway equipment, while from the farmer's standpoint the increase in the value of farms served by such a road would ultimately pay for its construction.

It is with the object of creating interest in the subject of light electric railways that this paper has been written; the details attending the building of such railways may properly be taken up later. If the suggestions offered in this paper result in the establishment of the light electric railway as a recognized and important part of the transportation industry in this country, the author's object will have been accomplished.

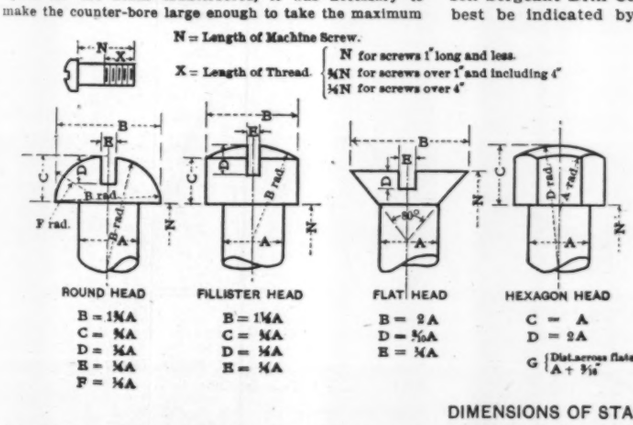
STANDARD HEADS FOR MACHINE SCREWS.*

By H. G. Reist,† M. Am. Soc. M. E.

The size and shape of machine screw heads as made by different manufacturers vary very greatly. In the case of screws made by some manufacturers the heads used on different sizes have different proportions, thus presenting a different appearance. The company with which I am connected is a large consumer of machine screws, and this variation has from time to time caused great inconvenience. Frequently designs are made to suit the screw heads of one manufacturer, and if afterwards it becomes desirable to purchase screws manufactured elsewhere, there may be an interference with other parts of the machine, due to the variation in size of heads. When fillister head screws were used with the space for the heads counterbored, it was necessary to make the counter-bore large enough to take the maximum size of head, thus not making a good appearance when smaller heads were used. The same was true in the case of flat-headed machine screws. The subject was taken up with several manufacturers of machine screws and it was found that they had no defined standard, but were open to suggestions, and were willing to supply screw heads to any ordinary dimensions without much if any extra cost.

In order to establish uniformity in our own works, we prepared the accompanying formula and table giving the shapes and dimensions of the heads of the size of screws ordinarily used.

It will be seen that these heads present a uniform appearance, and by submitting the table of dimensions we have had no difficulty in obtaining screws to the dimensions shown—in fact, the manufacturers have expressed themselves as pleased to have a standard to work to.



DIMENSIONS OF STANDARD MACHINE SCREWS.

Size of Screw.	No. of Threads.	Round Head Dimensions. A	B	C	D	E	F	Fillister Head Dimensions. A	B	C	D	E	Flat Head Dimensions. A	B	D	E
0	.....	.058	.102	.044	.029	.015	.029	.058	.087	.044	.029	.015	.058	.116	.017	.015
1	.....	.071	.124	.053	.036	.018	.036	.071	.107	.053	.036	.018	.071	.142	.021	.018
2	64	.088	.154	.066	.044	.022	.044	.088	.132	.066	.044	.022	.088	.176	.026	.022
3	48	.099	.173	.074	.050	.025	.050	.099	.149	.074	.050	.025	.099	.198	.030	.025
4	36	.113	.198	.085	.057	.028	.057	.113	.170	.085	.057	.028	.113	.226	.034	.028
6	32	.141	.247	.106	.071	.035	.071	.141	.212	.106	.071	.035	.141	.282	.042	.035
8	32	.166	.291	.125	.083	.042	.083	.166	.249	.125	.083	.042	.166	.332	.050	.042
10	32	.190	.333	.143	.095	.048	.095	.190	.285	.143	.095	.048	.190	.380	.057	.048
12	24	.221	.387	.166	.111	.055	.111	.221	.332	.166	.111	.055	.221	.442	.066	.055
14	24	.246	.431	.185	.123	.062	.123	.246	.369	.185	.123	.062	.246	.492	.074	.062

Size of Screw.	No. of Threads.	Hexagon Head Dimensions. A	C	D	G
14	24	.246	.246	.492	.434

*A paper presented at the Scranton meeting of the American Society of Mechanical Engineers.

†Mechanical and Electrical Engineer, General Electric Co., Schenectady, N. Y.

FIVE-YARD BOTTOM-DUMP WAGONS FOR CITY REFUSE.

The street cleaning department of Indianapolis, Ind., has recently bought 25 bottom-dump refuse wagons, each of 5 cu. yds. capacity. A good general idea of these wagons may be gained from the accompanying illustration. The upper and flaring part of each side of the wagon is hinged so it can be dropped while the first part of the load is being collected; or when desired these sides can be removed and put aside. With the sides lowered or removed the material being collected has to be lifted only 5 ft.

A LARGE BOTTOM-DUMP WAGON FOR CITY REFUSE.

A full load can be dumped by the driver in one place, simply by moving a lever close by his seat. The dumping bottom consists of two sheets of reinforced steel, one of which overlaps the other on the longitudinal central line of the bottom. The bottom pieces are held in place by chains, two to each piece, which wind over what the makers of the wagon term large spirals, one at each corner of the wagon box. The bottom is opened and closed by means of the lever already mentioned. The wagons were supplied by the Troy Wagon Works Co., of Troy, O.

THE NEW WORKS OF THE INGERSOLL-SERGEANT DRILL CO.

The magnitude of the new works of the Ingersoll-Sergeant Drill Co., at Phillipsburg, N. J., can best be indicated by stating that the buildings enclose a floor space of nearly half a million square feet. When one comes to walk through ten acres of machine shops, foundries, warehouses and other buildings housing such a plant as this, the importance of the business of making rock drilling and allied machinery is brought out more forcibly than by the reading of pages of statistics.

In 1880, according to the U. S. Census Reports, there were only 257 power-driven rock drills in the deep gold and silver mines of the United States. In 1902 the number was 3,329. This phenomenal increase in two decades, in one class of mines only, has doubtless been equaled in other fields of mining enterprise. Unfortunately, the Census Reports do not show the number of drills used in the iron, coal, copper and other mines, or in quarries. In South African gold mines the number of rock drills exceeds 2,500, and a very large percentage of these are of American make. Indeed, it is interesting to note in reading Aitken's admirable book on "Road Making," that he, although an Englishman in England, is using, by preference, Ingersoll drills.

These preferatory paragraphs serve to show the cause of the building of the new Ingersoll-Sergeant works. The old works, at Easton, Pa., have been outgrown, and will hereafter be used only for the manufacture of channelers and pneumatic tools. At the new works, rock drills, air compressors, coal cutters, etc., will be made.

The new works are located on a plateau of 200 acres, about 1½ miles east of the center of Phillipsburg. A concrete dam, 25 ft. high and 2,000 ft. long, impounding 31,000,000 gallons of water, has been built for the company, about 4½ miles from the shops. The water is delivered through a 16-in. main with a pressure of 100 lbs. at the works.

Fig. 1 shows a general plan of the new buildings, and the car tracks serving them. It will be observed that room has been provided for further expansion, when the growth of the business makes additional room necessary.

With the exception of the pattern shop, the pattern storage building and the carpenter shop, which are of mill construction, all the buildings are of steel and concrete construction. The floors are of concrete and the roofs are of reinforced concrete covered with felt and slag.

Fig. 2 shows the design of the sawtooth roof of building No. 17, which is the rock-drill manufacturing shop. Ribbed glass is used with this type of roof, and the result is an exceptionally well-lighted shop. A noteworthy detail in this connection is the placing of electric motors on small platforms resting on the lower chords of the roof trusses. Each main-line shaft, driven by a motor, extends longitudinally through each sawtooth bay, as shown in Fig. 2. Two countershafts, one on each side of the bay, are driven from the main shaft.

Fig. 3 shows a cross-section of the compressor-erecting shop, which is building No. 8 on the general plan. It will be noted in Fig. 3 that the trackways for the electric cranes of the buildings on each side project into the compressor-erecting shop, so that the electric cranes in this shop can deliver directly to the cranes of the other buildings.

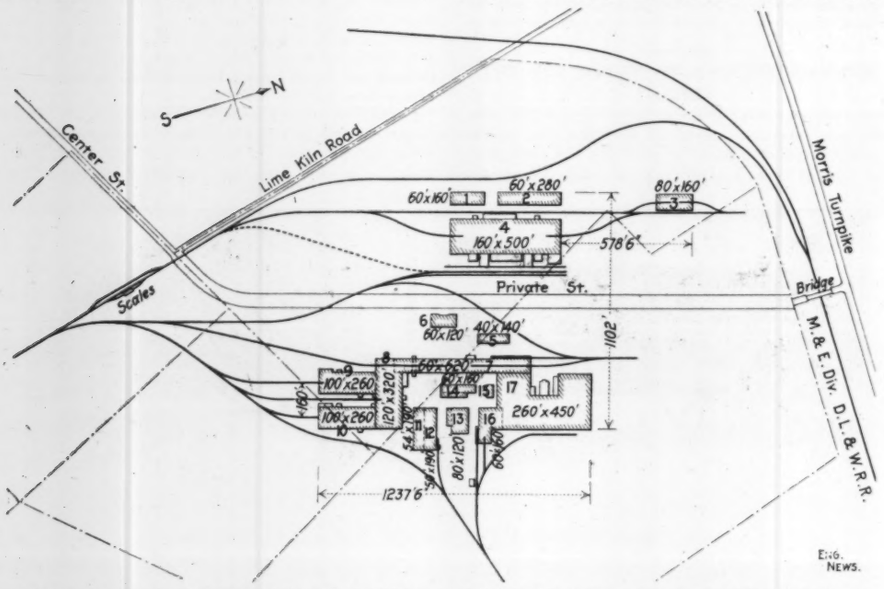


FIG. 1. PLAN OF NEW WORKS OF INGERSOLL-SERGEANT DRILL CO., PHILLIPSBURG, N. J.

1. Pattern Shop.
2. Pattern Storage Building.
3. Casting Cleaning Building.
4. Foundry.
5. Carpenter Shop.
6. Office Building.
7. Warehouse and Shipping Department.
8. Air Compressor Erecting Shop.
9. and 10. Compressor Machine Shops.
11 and 12. Power Plant.
13. Blacksmith Shop.
14. Steel Treating Department.
15. Rock Drill Testing Department.
16. Receiving Department.
17. Rock Drill Manufacturing Shop.

A cross-section of the power-plant building is shown in Fig. 4. The coal is dumped directly from the cars into a bin that feeds into a crusher from which it is conveyed by a Robins belt conveyor to a McCaslin bucket conveyor, and finally delivered into Berquist parabolic bins, from which it is fed to furnaces by Roney stockers. The ashes are shoveled from the pit into the same conveyor and delivered to the ash bin. There are six Stirling water-tube boilers, aggregating 1,500 HP., and four Cooper-Corliss cross-compound engines, direct-connected to Crocker-Wheeler generators, three of 300 KW. and one of 100 KW. Two steam-driven Ingersoll-Sergeant air compressors supply air at 100 lbs. and at 30 lbs. pressure.

A concrete-lined tunnel, 6 ft. square, and with its branches aggregating 2,200 ft. in length, carries the power and lighting mains, air pipes, water pipes, heating pipes, etc. The Evans system of hot-water heating, installed by Evans, Almirall & Co., of New York, is used for heating all the buildings. Exhaust steam is used for heating the water, but provision is made for using live steam also. The water is circulated through the mains and coils by means of De Laval Steam Turbine pumps, provided in duplicate.

The machine tools of the plant are driven by electricity, using the four-wire system of the Crocker-Wheeler Co. Individual motors are used for the large machines and group-driving for the smaller tools.

The design of the plant, including the buildings, was made by the engineers of the Ingersoll-Sergeant Drill Co., and all the steel work, excepting the foundry building, was erected by the company. The McClintock & Marshall Construction Co., of Pottstown, Pa., furnished and erected the steel work of the foundry building. The American Bridge Co. furnished the rest of the steel. The concrete roofs of buildings Nos. 3, 9, 10 and 17 were made by the Metropolitan Fireproofing Co., of New York, and the roofs of the other buildings by the American Concrete-Steel Co., of Newark, N. J. The New Jersey Roofing & Construction Co. laid all the felt and slag roofing. The Hay Foundry, of Newark, furnished the iron for the office building, and J. S. Thorn & Co., of Philadelphia, supplied all skylights. The electric cranes were supplied by Pawling & Harnishfeger Co., of Milwaukee, Wis., and by the Morgan Engineering Co., Alliance, O.

In charge of the design and installation of the plant were: Mr. W. L. Saunders, President of the Ingersoll-Sergeant Drill Co.; Mr. Geo. R. Elder, Vice-President and General Manager; Mr. William Prellwitz, Chief Engineer; Mr. H. W. Zook, Mechanical Engineer, and Mr. R. T. Stewart, Constructing Engineer.

THE ORGANIZATION AND ADMINISTRATION OF NATIONAL ENGINEERING SOCIETIES.*

By John W. Lieb, Jr.,† President Am. Inst. Elec. E.

The most important factors in promoting the advance of the engineering profession and in disseminating and rendering available to the world the valuable experience and data accumulated by engineers in the practice of their profession are the national engineering societies. The first important step in the association of engineers into a professional body was taken when in 1828 Thomas Telford in the name of 156 of his colleagues—some of whom had already formed a society as early as 1818—applied for Royal Charter for the Institution of Civil Engineers (of Great Britain). The original charter recites that the body is formed

> for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange, and in the construction of ports, harbors, walls, breakwaters and lighthouses, and in the art of navigation by artificial power for the purposes of commerce and in the construction and adaptation of machinery, and in the drainage of cities and towns.

It will be seen that this famous definition of the field covered by the profession of the civil engineer, as formulated by Telford, covers broadly all of the branches of modern engineering science, excepting military engineering and includes within its scope directly or by implication mechanical, mining, electrical and sanitary engineering and naval architecture.

It was not long before important discoveries in the realm of physical science and epoch-making inventions and improvements in the mechanical arts opened new fields of industrial activity and we find this broadening of the field covered by the engineer reflected in a differentiation of the profession, in Great Britian resulting in the organization in 1847 of the Institution of Mechanical Engineers, in 1869 of the Iron and Steel Institute, and in 1871 of the Society of Telegraph Engineers and Electricians, which became in 1889 the Institution of Electrical Engineers.

Coming now to our own country, the American Society of Civil Engineers was organized in 1852, the American Institute of Mining Engineers in 1871, the American Society of Mechanical Engineers in 1880, and the American Institute of Electrical Engineers in 1884. While these are the distinctively National Engineering Societies, there are other technical associations like the Society of Naval Architects and Marine Engineers, the American Society of Heating and Ventilating Engineers, the American Street Railway Association, Association of Engineering Societies, etc., which although of national importance, do not come within the scope of our subject.

There are still many other professional bodies in the United States identified with the engineering profession, some of a national character, which in addition to professional activities are also associated for commercial relations and whose memberships consist largely of business corporations, such as the National Electric Light Association and the Association of Edison Illuminating Companies, and still others largely local in character, such as the Pacific Coast Transmission Association, the Engineers' Society of Western Pennsylvania, and the league known as the Association of Engineering Societies representing a total membership of 1766 in eleven local Engineers' Clubs or Societies.

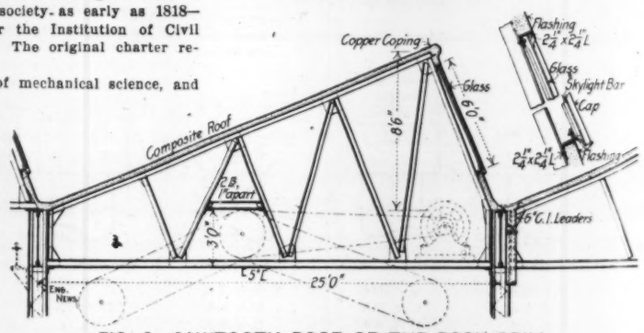


FIG. 2. SAWTOOTH ROOF OF THE ROCK DRILL MANUFACTURING SHOP.

In this review we shall confine ourselves to the four national engineering societies first referred to, with some reference to the corresponding bodies in Great Britian and on the Continent.

The membership of these bodies divided into the several classes according to their last official reports, is given in the accompanying Table I. As a matter of general interest there is also added in Table II a tabulation of the more important European engineering societies.

A study of the annual reports of these bodies from year to year and of their Constitutions and By-Laws is

TABLE I. NATIONAL ENGINEERING SOCIETIES IN THE UNITED STATES.

Name and Date of Organization	Date of Report	Hon. Members	Full Members	Assoc. Members	Juniors	Total
American Society of Civil Engineers, 1852	Jan. 1, 1905	9	1795	903	[illegible]	3201
American Institute of Mining Engineers, 1871	Jan. 1, 1905	7	3483	—	[illegible]	3690
American Society of Mechanical Engineers, 1880	Jan. 1, 1905	19	1915	[illegible]	[illegible]	2780
American Institute of Electrical Engineers, 1884	Jan. 1, 1905	2	481	2851	[illegible]	3334

* Including 27 Fellows.

TABLE II. FOREIGN ENGINEERING SOCIETIES.

Name and Date of Organization	Date of Report	Hon. Members	Full Members	Assoc. Members	Juniors	Total
Institution of Civil Engineers (of Great Britain) 1818	Jan. 1, 1905	19	2191	[illegible]	[illegible]	*5597
Institution of Mechanical Engineers 1847	Mar. 1, 1905	9	2351	[illegible]	[illegible]	†3907
Iron and Steel Inst., 1869	Jan. 1, 1905	11	1898	—	[illegible]	1909
†Institution of Electrical Engineers 1889	Aug. 31, 1904	6	*1101	[illegible]	[illegible]	‡4303
Verein Deutscher Ingenieure, 1891	Apr. 24, 1903	6	17543	—	[illegible]	17549
Société des Ingénieurs Civil de France, 1848	1901	—	—	—	—	3691

* Includes 136 Foreign Members.
* Not including 1144 Students or Graduates.
† Originally organized as the Society of Telegraph Engineers and Electricians in 1871.
‡ Not including 480 Students or Graduates.
‡ Not including 1107 Students or Graduates.

*From the Presidential Address at the Asheville Convention of the American Institute of Electrical Engineers.

†Third Vice-President and Associate General Manager, The New York Edison Co., 55 Duane St., New York City.

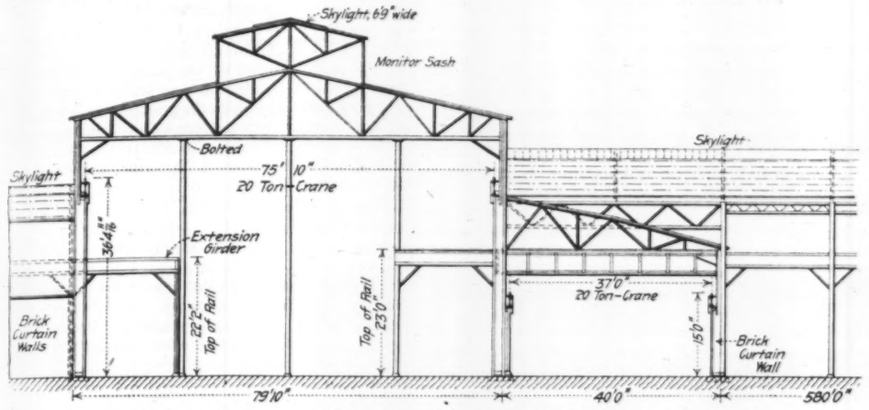


FIG. 3. CROSS-SECTION OF THE AIR COMPRESSOR ERECTING SHOP.

any abnormal development which may detract from its efficiency as a whole, or result in purely local development at the sacrifice of general usefulness and national standing.

One of the very first questions we encounter is that of the grades of membership, then the requirements of admission to them, and the method of election. These questions are of fundamental importance and they are worthy of the closest attention, as upon them more than upon any other feature of the organization will depend the professional standing of the society and its healthy growth in membership and influence. There is no honor within the gift of the society which requires the exercise of so much judgment, such fidelity to its interests, such conscientiousness, impartiality, and impersonality as membership on the Board of Examiners or Committee on Admissions and it is deserving of the highest recognition.

The requirements for full membership vary greatly in the four societies, as we shall see from the following abstracts from their Constitutions:

AMERICAN SOCIETY OF CIVIL ENGINEERS.
Constitution—Article II—Membership.

2. A Member shall be a Civil, Military, Naval, Mining, Mechanical, Electrical, or other professional Engineer, an Architect or a Marine Architect. He shall be at the time of admission to membership not less than thirty years of age, and shall have been in the active practice of his profession for ten years; he shall have had responsible charge of work for at least five years, and shall be qualified to design as well as to direct engineering works. Graduation from a school of engineering of recognized reputation shall be considered as equivalent to two years' active practice. The performance of the duties of a Professor of Engineering in a technical school of high grade shall be taken as an equivalent to an equal number of years of actual practice.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Constitution—Article II—Members.

Sec. 3. The following classes of persons shall be eligible for membership in the Institute, namely: As Members, all professional mining engineers, geologists, metallurgists or chemists, and all persons practically engaged in mining, metallurgy or metallurgical engineering.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Constitution—Membership.

C 9. A Member shall be thirty years of age or over. He must have been so connected with Engineering as to be competent, as a designer or as a constructor, to take responsible charge of work in his branch of Engineering, or he must have served as a teacher of Engineering for more than five years.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
Constitution—Article II—Membership.

2. A Member shall have been an associate, and at the time of his transfer to membership he shall be not less than twenty-seven years of age, and shall be:
a. A Professional Electrical Engineer; or
b. A Professor of Electrical Engineering; or
c. A person who has done important original work, of recognized value to electrical science.

3. To be eligible to membership, as a professional Electrical Engineer, the applicant shall have been in the active practice of his profession for at least five years; he shall have had responsible charge of work for at least two years, and shall be qualified to design as well as direct electrical engineering works. Graduation from a School of Engineering of recognized standing shall be considered the equivalent of one year's active practice.

4. To be eligible to membership as Professor of Electrical Engineering, the applicant shall have been in responsible charge of a course of Electrical Engineering at a college or technical school of recognized standing for a period of at least two years.

It will be seen that two of the societies fix an age limit of 30 years, one 27 years and one fixes no limit; one requires professional practice of 10 years, one 5 years, two no time specified; three require professional competency in designing as well as constructing or directing engineering works, one requires the applicant to be professionally or practically engaged in the branch.

In the case of the Mechanical Engineers and the Civil Engineers the election is by ballot of the membership at large after approval by the Executive Board or Council; in the case of the Mining Engineers and Electrical Engineers, election is by direct vote of the Board of Directors, in the latter after submitting the names to the membership at large, in the former without submission. In the Mining Engineers, Mechanical Engineers, and Electrical Engineers the application is first passed upon by a Board of Examiners and then by the Executive Board or Council; in the case of the Civil Engineers by the Board of Directors directly without action by an Examining Board. The Electrical Engineers' Constitution requires that all Members be first elected as Associates and then transferred by the Board.

It will be seen from the above how different the requirements are for full membership in the several societies, and how varied the procedure for election. It would appear at first thought that the more explicit the Constitution in its exact definition of the conditions for membership, the easier it would be for the Membership Committee to act, but this is by no means always the case as it often prevents the taking of a broad view of the candidate's eligibility and is apt to exclude desirable material on very technical grounds although on the other hand it is a protection against loose interpretation of the requirements by careless examiners. There would seem to be a better division of responsibility and more direct control of the class of men admitted to membership by giving wide publicity to their candidacy and election by ballot by the membership at large, after the candidates have passed the scrutiny of the Board or an Examining Committee. A young society covering a branch of engineering that has but recently become specialized cannot in the beginning impose rigorous requirements as to age limits or time of professional service and the branch of engineering may be such as to make it difficult to impose severe technical requirements.

In the case of the Civil Engineers the accepted definition is sufficiently broad to cover applicants who are professionally engaged in any of the other branches of engineering; the Mechanical Engineers' definition is somewhat less comprehensive, the Mining Engineers still less so, and the Electrical Engineers really restrictive to professional electrical engineers. Under our Institute's constitution, however eminent a man may be as a civil, mechanical or mining engineer, he may not fulfil the qualifications of an electrical engineer. It will thus be seen that anything like standardization in the matter of requirements is wholly out of the question, although a greater uniformity in requirements and procedure for election would be advisable.

We now come to the question of the dues and at the same time we may with advantage consider the general question of the income and expenditures or the cost of conducting the business of the societies. The expense of membership in the several societies is as follows:

	Entrance Fees.			Annual Dues.		
	Juniors.	Associates.	Members.	Juniors.	Associates.	Members.
Am. Soc. C. En..	$10	$20-25	$30	$10-15	$10-15	$15-25
Am. Inst. Min. En..	—	10	10	—	10	10
Am. Soc. Mech. En.	15	25	25	10	15	15
Am. Inst. Elec. En.	—	5	15	—	10	15

In view of the new relations entered into between the three national engineering societies, which are to occupy jointly the Union Engineering Building, and as the societies have now roughly about the same membership, it would appear to be desirable to have membership dues as nearly on a unform basis as practicable.

It would appear that the entrance fees of our Institute might be revised without disadvantage, increasing the entrance fees for Associate to at least $10 and a payment of an additional $15 on transfer, a total of $25 for full membership. An increase in annual dues also is not at all improbable in the near future, and they might with advantage be increased to $15 for resident Associates (within 50 miles of New York) and to $25 for resident Members; this increase for resident membership would seem to be warranted by the greater advantages enjoyed by the membership residing in or near New York, more especially after the occupancy of the Union Engineering Building.

Let us now consider the annual receipts and disbursements per paying member per year in the four societies. These figures are presented purely as a matter of general interest and not at all of invidious comparison; the table of receipts and disbursements per member is subdivided under appropriate heads as accurately as they can be compiled.

It should be borne in mind that no deductions of value

TABLE III.—RECEIPTS AND DISBURSEMENTS PER YEAR PER MEMBER.

Receipts:	Civil.	Mining.	Mechanical.	Electrical.
Entrance fees	$2.50	$0.28	$2.45	$0.83
Dues	16.99	10.64	14.04	9.30
Transactions, sales and adv.	1.86	2.00	1.64	1.70
Badges and certificates	.65	—	—	.28
Interest	.36	.34	—	.21
	$22.45	$13.35	$18.13	$12.32
Disbursements:				
Transactions	$4.63	$5.28	$7.50	$3.77
Salaries, etc.	6.13	4.22	3.99	2.20
Meeting expenses	.20	.30	.94	.82
Library, including rent and salaries	.30	.80	.39	.81
Rent	2.84	.74	2.79	.75
Stationery & misc. printing	.62	.34	1.19	.70
Postage	1.10	1.02	.26	.66
General expenses	.34	.47	.11	.54
Badges and certificates	.50	—	.33	.25
Express	—	.83	—	.22
Totals	$16.75	$14.00	$17.50	$10.72
Credit balance per member	$5.70	$0.65*	$0.63	$1.60

*Deficit.

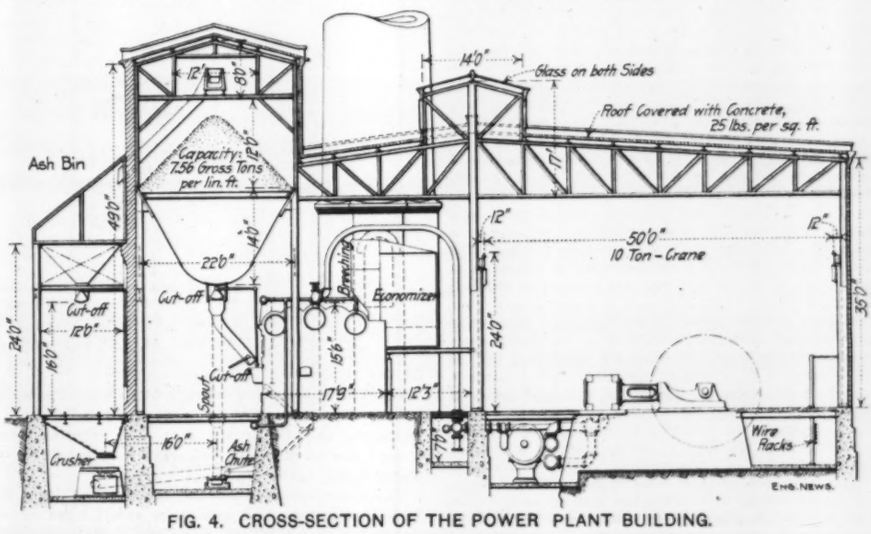


FIG. 4. CROSS-SECTION OF THE POWER PLANT BUILDING.

can be drawn from a mere comparison of the figures of Table III. alone; take the cost of the "transactions" for instance: In order to make a comparison of the relative economy with which this item is handled in the several cases, it would be necessary to know in each instance the number of pages, number of cuts, number of advance copies distributed at meetings or in monthly advance publications in addition to the regular annual volumes. The figures therefore represent the amounts which are being spent on the several items, rather than a comparison of their economic handling; it would be fallacious to assume that the figures necessarily represent the comparative economy with which the societies conduct the items in the table.

It may also be interesting to compare the receipts and disbursements per Institute member during the past five years, in which the membership has increased from 1,200 to 3,400.

TABLE IV.—AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—RECEIPTS AND DISBURSEMENTS PER YEAR PER MEMBER. DURING EACH FISCAL YEAR FOR THE PAST FIVE YEARS.

Year	1901	1902	1903	1904	1905
Membership	1260	1549	2230	3027	3460
Receipts per member:					
Entrance fees	$0.61	$1.16	$1.59	$1.65	$0.83
Dues	8.61	10.06	9.01	9.33	9.30
Transactions, sales and advertising	1.03	1.54	1.79	2.11	1.70
Badges	.18	.26	.35	.39	.28
Interest	.12	.24	.21	.18	.21
	$10.55	$13.26	$12.95	$13.66	$12.32
Disbursements per member:					
Transactions	$2.83	$3.50	$4.67	$3.43	$3.77
Salaries	2.49	2.78	2.49	2.50	2.20
Meeting expenses	1.05	1.13	.87	1.16	.82
Rent	.94	.94	.65	.79	.75
Library, including rent and salaries	.55	1.85	1.38	1.39	.81
Postage	.46	.51	.69	.66	.66
Stationery and miscellaneous printing	.39	.53	.96	1.01	.70
General expense	.33	.59	.52	.45	.54
Badges	.16	.19	.27	.35	.25
Express	.15	.15	.15	.28	.22
Total	$9.35	$12.17	$12.95	$12.02	$10.72
Credit balance per member	$1.20	$1.09	$0.00	$1.64	$1.60

Our next concern is with the officers of the societies and the method of nomination and election. A truly national society should draw its membership from all parts of the country and should afford representation in its officers and on its administrative committees to the membership at large; in other words, should select its officers as far as possible with a view also to geographical distribution. It is admitted that this is difficult owing to the opportunities afforded to practicing engineers by large enterprises whose administration, technical as well as financial, is located in the important commercial centers, hence the important groups of members in the large cities. From these are drawn the majority of the officers, such selection being emphasized by the necessities of the central administration of the society. Such tendencies, however, are apt to operate to the disadvantage of available candidates for the important posts of honor within the gift of the societies who may happen to be stationed some distance away from headquarters and to keep the institution on the plane of national standing it should also have a care to broad geographical distribution. This end can best be accomplished by providing for a nominating committee selected according to a geographical distribution into approximately equal groups of members, each geographical district consisting of say 300 or 400 members, and upon these, in consultation with a number of past officers, would rest the selection of the official nominees, with provision also for the filing of such nominations as may be made directly by the general membership. This procedure was introduced by the American Society of Civil Engineers several years ago. Such a plan would provide geographical representation and at the same time discourage unseemly electioneering and circularizing for the coveted posts of honor. It is thought by some that our own Institute could with advantage modify its own procedure in this direction.

We have already referred to the importance of conducting a national society on broad lines so that the members at large should have a share in the benefits as well as the obligations of membership whether they be located near the headquarters of the society or at a distance. It is manifest that when the monthly meetings, as well as the more important annual functions, are held at the headquarters of the society, the members at a distance feel that they are at a disadvantage, and there is a tendency to form local clubs or organizations and secede from the parent society or at least lose interest in it. Our Institute has met this situation courageously and through the initiative of Past-President Scott a series of local organizations was established and they have been added to under succeeding administrations; these organizations have done much to keep up the interest at distant points and they have undoubtedly induced desirable accessions to our membership and have been an important stimulant of professional activity.

Our sister societies are facing the same problem and are watching the result of our undertaking—it can no longer be called an experiment—with great interest. But this scheme of local organizations while undoubtedly successful, is developing new problems and new conditions and requires the constant care and supervision of the central administration.

It is in meeting and solving such new problems of society administration as I have referred to, that the youth and enthusiasm of our members is of the utmost advantage. We are less handicapped by precedent and tradition than some of our older sister societies, and we may therefore expect for the Institute of Electrical Engineers a glorious future full of activity, initiative, and prosperity, and successful in the attainment of the highest professional standing, dignity and usefulness.

THE CAVE-IN OF THE GUNNISON TUNNEL NEAR MONTROSE, COLO.

Further particulars regarding the cave-in of the Gunnison tunnel (see p. 606 of our issue of June 8, 1905) have been delayed awaiting a promised report from Mr. I. W. McConnell, of Montrose, Colo., Engineer-in-Charge. As can be understood, Mr. McConnell has been very busy since the accident, so his report to this journal was necessarily delayed. Meanwhile Mr. A. P. Davis, Acting Chief Engineer of the U. S. Reclamation Service, has supplied us with a blue print, reproduced herewith, showing a section of the tunnel, location and nature of the break, and also a graphic account of the cave-in and the rescue of the entombed men, evidently prepared at the scene of the accident and apparently forwarded through Mr. J. H. Quinton, Supervising Engineer for Colorado of the U. S. Reclamation Service. Mr. McConnell's report to this journal, dated June 17, is first given, after which may be found the more detailed account of the rescue, just mentioned:

MR. McCONNELL'S ACCOUNT OF THE ACCIDENT IN THE GUNNISON TUNNEL AND OF SUBSEQUENT EVENTS.

The Gunnison Tunnel, now under construction by the United States Reclamation Service, will be used as a diversion channel to carry the water of the Gunnison River into the Uncompahgre Valley. The tunnel, when completed, will be over 30,000 ft. in length, with a carrying capacity of 1,300 sec. ft. The water way will be 10 ft. in width at the bottom, with an approximate height of 14 ft. to the crown of the arch.

This work was advertised for contract and was let in the winter of 1904-5 to the Taylor-Moore Construction Co., of Hillsboro, Tex. Work was begun early in January by the contracting firm, and was carried on in a more or less satisfactory manner until May 27, 1905. The contractors became involved in financial difficulties, and on May 28 the government officials took possession of the work. As it was very important to keep the work going, the contractor's organization was not changed, and the same men and foremen continued the work night and day in three shifts of eight hours each.

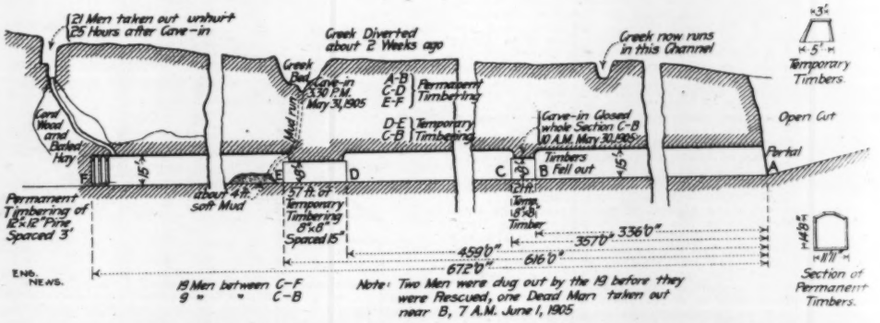
The cave occurred on the morning of May 30. The contractors had run in a small heading at grade for about 700 ft. from the portal, and had been ordered at the beginning of May to enlarge the heading to full size and to put in the permanent timbering so that the tunnel should be perfectly safe. When the accident occurred all of this work had been done except two stretches, one of 21 and one of 57 ft. The cave occurred at the 21-ft. stretch. The ground encountered at this end of the tunnel is of a very treacherous nature, being composed of layers of varying thickness of adobe, sand and gravel, with occasional seams of mud and water. Where the cave occurred the nature of the ground was such as to lead the timbermen to believe that they were safe in supporting this 21-ft. stretch with temporary timbering until the permanent timbers could be placed. In this supposition it now appears that they were mistaken, for an examination of the ground in the cave shows that there was a bed of gravel and sand immediately above the haulway, and the entire 21 ft. caved in without warning whatever, filling the tunnel with the debris. Naturally there were many vacant spaces left in the tangled mass of timbers, and in these spaces four of the men caught in the cave were imprisoned. While this 21-ft. stretch was being timbered there were 19 men employed in pushing ahead the face of the tunnel; that portion of the tunnel in which they were working being about 180 ft. long between the 57-ft. stretch and the face. When the cave occurred, of course these men were cut off from exit from the tunnel, but they were released in about 24 hours, by sinking a shaft from the surface. Of the four men who were caught in the timbers alive, two were rescued by this gang before they were released from the tunnel. Two others remained unhurt in the timbers for 50 hours, when they were rescued. The other six men caught in the cave were instantly killed.

Most of the men employed in the tunnel are hard ground miners, and are not as well versed in handling soft ground as railroad tunnel men. Of course there has been a different foreman in charge of each shift, and an error of judgment on the part of any of these men as to the nature of the ground would cause a fatal accident. The methods employed by the contractors for driving the tunnel were not approved by the engineers, and they were ordered to change them, but during the process of changing the accident occurred.

The cave was cleared away and the last of the dead bodies recovered during the afternoon of June 8. Although the ground in places is very heavy, the permanent timbers have not shown the least sign of settlement. If they do, however, concreting will be commenced, and continued until the heavy ground is passed.

ACCOUNT OF THE RESCUE, AS FORWARDED BY MR. DAVIS.*

The cave-in occurred at 10:30 a. m., May 30, coming in upon the shift of workmen which had gone on at 7 a. m. The men were distributed at various kinds of work all along the tunnel, which is 675 ft. in length. They were putting the permanent timbers in place, clos-


21 Men taken out unhurt 25 Hours after Cave-in
Creek Diverted about 2 Weeks ago
Creek now runs in this Channel
Creek Bed
Cave-in 3:30 P.M. May 31, 1905
A-B C-D E-F Permanent Timbering
D-E C-B Temporary Timbering
Cave-in Closed whole Section C-B 10 A.M. May 30, 1905
Timbers Fell out
Temporary Timbering
Permanent Timbering 12"x12" Pine Spaced 3'
about 4 ft. soft Mud
57 ft. of Temporary Timbering 8"x8" Spaced 15"
Temp. 8"x8" Timber
Open Cut
Portal
Temporary Timbers
Section of Permanent Timbers.
19 Men between C-F
9 " " C-B
Note: Two Men were dug out by the 19 before they were Rescued, one Dead Man taken out near B, 7 A.M. June 1, 1905
459'0"
672'0"
616'0"
357'0"
336'0"

SKETCH, LONGITUDINAL SECTION OF GUNNISON TUNNEL, ILLUSTRATING CAVE-IN.

ing up the three divisions. At 336 ft. from the portal a crew of men were laying the mudsills and arranging the timbers to put in the last 9-ft. set connecting the two divisions. Before the cave-in the only warning given the men was to Smithley, who saw a little sand trickle through the temporary timbers. He called instantly to the boys to get out, but before they could scarcely move they were caught in an avalanche of crushed timbers, mud and debris. Five men working just at the edge escaped. The trammer on a carload of dirt pulled by a horse had just passed this point. The rush of wind knocked him off the car, and the latter was pushed off the track.

A short time after the cave-in occurred the workmen on the outside heard taps on the pipe line and they answered immediately, receiving a response, which indicated that at least some of the men behind the cave-in were alive. After a hurried consultation it was decided to

*A few local items have been omitted.—Ed.

sink a temporary shaft down to the tunnel, a distance of about 50 ft. No time was lost in starting it and men worked as never before in throwing out the dirt with pick and shovel. They changed every three minutes and the shaft seemingly went down with lightning rapidity. At 10:30 the next morning, just 24 hours after the accident occurred, an opening was made to the entombed men. Nineteen were found to be alive.

Grasser (in charge of the timbering crew—Ed.) was the first one to climb the ladder to the surface, he being the weakest of the bunch. He had been caught in the falling mass and remained under it for over nine hours. He happened to fall near the drainage trough and finally managed to extricate himself sufficiently to work down into this boxing. By pulling the dirt out, he worked his way along in the box until the edge of the debris was reached. His companions then assisted him out in a completely exhausted condition. Otherwise he was uninjured.

Fortune smiled upon Smithley in like manner. When he recovered his senses after the first crash he found he was holding the hand of some one. The dirt and mud were pretty tight about him, but he felt all right otherwise. He attempted to remove the dirt from his partner, following his arm up toward his face, but this was impossible, so he held his hand for what he believes was two hours, when the hand dropped limply and soon became cold. It was then that he supposes the poor fellow died. Smithley began trying to dig himself out and finally worked into the trough which had saved Grasser. By this time more mud and water had accumulated in the boxing, and it was with the greatest difficulty that he could find room to move himself. He would stick his face down in the water and push ahead as long as he could hold his breath, then raise his face up long enough to breathe. This performance was repeated until he got within about 6 ft. of safety. He was then exhausted and could get no further. He called for assistance, and the entombed men came to the rescue. They pushed in a long bar of steel to him, which he grasped and they pulled him out.

The imprisoned men were working all the while, some constructing a dam across the bottom of the tunnel to hold the water, and others shoveling away the debris. They kept in good spirits, believing that succor would reach them before perishing. When reached they were standing in water up to their knees. As soon as they got to the surface, they all started to the portal entry, saying that they were going to aid in rescuing their companions. Such bravery and fortitude are seldom witnessed. They were finally induced to obtain food, dry clothing and rest, as there were plenty of fresh men handy.

Meanwhile every man that could find a spot to work in was in the tunnel shoveling debris into the cars. Little headway was made here as the dirt came in as fast as taken out. It was fully a day before the ground could be held in place. While working there it was found that some were still alive under the debris, for their calls could be heard distinctly. Every energy was put forth. By Wednesday morning they had gotten in far enough to converse with these men, who were found to be Fred Groff and Ben Taylor. They were pinned tightly, but were experiencing no pain other than the fatigue and distress of lying in one position. Every effort to release them proved futile, as the removal of a single timber might start another slide and certainly kill them. These men believed they could hold out and told the workers to take their time. Another day passed and still they could not be released. By Thursday morning the men were very weak, but nourishment was passed in to them through openings between the timbers. At one o'clock in the afternoon the timbers had been braced sufficiently to remove those which held Taylor and he was pulled out. He simply complained of stiffness and rheumatism and was exceedingly jovial all the time. Three hours later Groff was extricated by placing straps around his ankle and six men pulling him through an aperture which seemed scarcely large enough to accommodate his limbs. He was the weaker of the two, but stood the ordeal bravely.

Wednesday afternoon the bed of Cedar Creek, through which a very small stream of water was running, fell in and a quantity of mud ran into the tunnel at 615 ft. from the portal, or 60 ft. from the breast. It created considerable consternation but did no great damage. This was 280 ft. from where the first cave-in occurred.

The men who have been rescued say that no blame can be attached to any one for the accident, that it resulted from no carelessness, but was one of those unavoidable accidents which occur in like enterprises. The temporary timbers where the cave-in occurred were very strong and numerous, and when this ground was first passed through it did not show the slightest indication of sliding.

A STREET RAILWAY SUBWAY system is proposed at Cleveland, O., to relieve the congestion of street and interurban cars and general traffic in the center of the city. The matter is being investigated by a special committee of the Chamber of Commerce and by the street railway company.

ANDREW ONDERDONK.

Andrew Onderdonk, General Manager of the New York Tunnel Co. and one of the best known of American contractors, died on June 20 at his summer residence at Oscawana, N. Y., from heart failure, said to have been brought on by overwork. The company of which Mr. Onderdonk was the head has two very large contracts under way, one being the tunnel under the East River for the Brooklyn extension of the New York Rapid Transit Subway. The other contract is the dredging of Ambrose Channel, the new 40-ft. entrance to New York Harbor, a work which it is estimated will cost the United States Government more than $10,000,000.

Mr. Onderdonk's earliest work of magnitude was the dredging of San Francisco Harbor, prior to 1880, the contract involving several million dollars. His next great work was the building of 400

Andrew Onderdonk.

miles of the Western division of the Canadian Pacific Ry., through British Columbia. This work was done between 1880 and 1885, the contract amounting to $18,000,000.

In 1886 Mr. Onderdonk constructed the Entre Rios Railroad in South America. In 1887 the contract was awarded to him for the four-mile tunnel under Lake Michigan, one of the inlets of the Chicago water supply. The work was exceedingly difficult and was not completed until 1892. A full description of the work was given in our issue of September 8, 1892.

In 1895 Mr. Onderdonk built part of the Trent Valley Canal for the Canadian Government. He also built a double track railway tunnel in Hamilton, Ont.

In connection with the Union Bridge Co., of New York, he built the Northwestern Elevated Railway in Chicago, and secured contracts for half of the new Victoria Bridge at Montreal, and for four sections of the Soulanges Canal, in Canada.

Mr. Onderdonk was the only bidder against John B. McDonald for the New York Rapid Transit Railway franchise and contract which was let in 1900.

Mr. Onderdonk was born 56 years ago in New York City and leaves a widow, three sons and two daughters. He was a member of the Rideau Club of Ottawa, Canada, the Metropolitan Club, New York, and the Ardsley Country Club.

ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION.

The annual convention of the Master Car Builders' Association, held at Manhattan Beach, New York, on June 19, 20, and 21, was one of the best attended and most successful meetings of this organization ever assembled. The business transacted was of great importance and was conducted expeditiously. For the first time in several years the discussion of the interchange rules aroused a combat on the floor, which made the confirmed convention goers recall the days of the Chicago interchange agreement and the fight for its adoption by the Association. Mention was made in our report of the Master Mechanics' Association last week of the excellent exhibit of railway appliances. This of course was the same for both conventions.

BUSINESS PROCEEDINGS.

The proceedings of the convention were opened with an address by President W. P. Appleyard, from whose remarks we select the following:

Developments in the mechanical branch of transportation during the past year lead me to mention some of those which have attracted wide attention.

One of the most notable, and to my mind one fraught with the most radical change in railroad power and equipment in the near future, is that the high power and efficiency developed in the recent trials of electric traction by the New York Central & Hudson River R. R. Co., not because the simple fact of electric traction is new, because it is not, but because of the high efficiency, great power and speed displayed by the electric engines. The changes which electric traction will bring to car equipment of steam railroads may not be great, but some problems involved by the adoption of the new power will find their way to the master car builders. Do we fully realize, or even remotely guess at what is going on in the field of automobile traffic? Has it occurred to you that with the advent of good roads now yearly increasing so fast as to be scarcely comprehended, the automobile is swiftly to become a great factor in transportation, and that as machines are improved in power and endurance they will force a still more rapid development of good roads until it will prove a race as between roads and machines. . . . I predict that eventually national highways—broad, enduring and beautiful—will be laid like great bands from ocean to ocean, from the Gulf to the Canadas, over which high power vehicles will travel in endless streams. And yet, above all, there is in the dim distance the flying machine, developed already to dirigibility and long sustained movement. Nobody knows where that many land us.

Steel cars, both freight and passenger, are permanently with us, and while the problems incident to their construction and maintenance are being steadily worked out, there is yet much to be done to adapt them to conditions of service.

Friction draft gear is beginning to receive the consideration which it deserves, and will undoubtedly prove a most valuable adjunct to our equipment when it comes into general use. In this connection I earnestly commend to you for thought and definite action means for obtaining the proper amount of side movement in couplers. . . . We are aware of the great strains imposed upon draft timbers and couplers, to say nothing of the wheel flange wear and destruction of rail, due to the fixed position of the coupler. Much has already been accomplished in this direction, and it remains for this association to take cognizance of the necessity and arrange for definite action following the report of your Draft Gear Committee. I have always maintained that any device or appliance, even though somewhat inferior, would, if made standard on all railroads, be far more desirable than many better devices which are not interchangeable, and because of this I hope that we shall have the courage of our convictions and adopt as recommended practice, and then as standards, things which we believe to be the best for our equipment and which could be made a common standard. In line with this I ask your earnest thought, discussion and action on the report of your Coupler Committee, looking to more closely defining and standardizing the make up of the M. C. B. coupler, and eventually to a single standard as a whole.

At a joint meeting of the Executive Committee of the Master Mechanics' and Master Car Builders' associations, held in New York, Dec. 3, 1904, it was unanimously voted that a union of the two associations, in any form, was not desirable. It was decided that no time could be saved, nor could better results be obtained; hence the action taken.

The report of the Secretary showed a membership of 607 and a balance in the treasury of $3,469. The dues for the ensuing year were made $4 by vote of the convention. The Executive Committee proposed an amendment to Section 2, Article III of the Constitution as follows:

Section 2. Any person holding the position of superintendent of the car department, master car builder, assistant mechanical superintendent, mechanical engineer, assistant mechanical engineer, assistant engineer of motive power, chief draftsman, foreman of a railroad car shop, joint car inspector, or one representative from each car manufacturing company, or other company owning or operating over 1,000 cars which are not in process of purchase by other parties, may become an active member by paying his dues for one year.

The purpose of this amendment is to make eligible for membership many persons of use to

the Association who are now excluded by the Constitution. It was also proposed that Section 5, Article II be so amended as to make members of twenty years' standing eligible for life membership. These amendments will be voted upon at the convention of 1906. Upon request from the President, Mr. E. A. Moseley, President of the Interstate Commerce Commission, delivered a brief address. The election of officers at the last session of the convention resulted as follows: President, Joseph Baker, Assistant Superintendent of Machinery Illinois Central R. R., Chicago, Ill.; First Vice-President, W. E. Fowler, Master Car Builder, Canadian Pacific Ry., Montreal, Canada; Second Vice-President, G. N. Dow, Master Car Builder, Lake Shore & Michigan Southern Ry., Collingwood, Ont.; Third Vice-President, R. F. McKenna, Delaware, Lackawanna & Western Ry., Scranton, Pa.; Treasurer, John Kirby; Executive Committee, H. M. Carson, G. W. Wildin and T. H. Curtis.

TECHNICAL REPORTS AND PAPERS.

The technical work of the convention comprised the reading and discussion of special and standing committee reports. These are considered briefly here in the order in which they came up for discusison:

TRIPLE VALVE TESTS.—This standing committee reported that one triple vale had been received during the year for test, but that it had been presented too late to make it possible for the tests to be completed in time to present the results to the convention. The committee also requested that it be discharged and a new committee be appointed, which should be composed of men having expert knowledge of air brakes. This request was granted by vote of the convention.

BRAKE SHOE TESTS.—This committee reported that four brake shoes had been submitted for test during the year; one was a plain cast-iron shoe with a 3½ × 13⅜ in. face; one a cast-iron shoe with a 3½ × 14⅜ in. face backed or reinforced by a steel plate; one a composition shoe made by the Pittsburg Brake Shoe Co. for cast-iron wheels, and one a composition shoe made by the same company for steel-tired wheels. The results of the tests showed in all cases greater friction than is demanded by the Association's specifications.

STANDARDS AND RECOMMENDED PRACTICE.—The committee on this subject reviewed the present standards and recommended practice of the Association, and suggested changes in a number of the designs. Only a few of the changes recommended went beyond simple changes in minor details, and there was very little discussion on the report. With a few exceptions the recommendations of the committee were adopted by vote of the convention.

AIR-BRAKE HOSE.—At the convention of 1904 a special committee on this subject presented a set of specifications to cover the purchase of air-brake hose. These specifications were a decided modification of those that had been in previous use, and before adopting them the convention decided to have the question of the reliability of hose, such as would be furnished by manufacturers in compliance with the new specifications, thoroughly tested. The present report is the result of the investigations of the committee appointed to conduct these tests. They were carried out at the laboratories of Purdue University and comprised altogether nearly 500 sets of hose. The report gave in detail the results of all the tests, and also described the manner in which each of the several tests was conducted and the different machines by which the work was done. As a result of the detail figures, the committee recommended that the specifications proposed last year should be submitted to letter ballot for adoption by the Association. In presenting the report of the committee, the chairman stated that since it had been put in type it had been decided to add a recommendation to the effect that air-brake hose which did not correspond to the specifications of the Association should be considered wrong repairs. In the discussion which followed the report, Mr. A. E. Mitchell (L. V.) stated that he had been informed that manufacturers could not produce hose which would meet the specifications. In answer to this statement the chairman of the committee announced that he had consulted with a large number of manufacturers of hose, and that without exception they professed their ability to furnish an article which would meet all the new requirements. Mr. A. W. Gibbs (Penn.) stated that the committee had made no reference to woven hose. He wished to point out that this kind of hose was now going into quite extensive use, and that it was quite important that the railways of the country should have some standard by which to measure its durability. He asked, therefore, that the committee should take up the question of woven hose and prepare a specification for it, or else include such paragraphs in the present specifications as would cover this quality. The report was referred to letter ballot by vote of the convention.

M. C. B. COUPLER TESTS.—The standing committee on this subject presented its usual elaborate report. This report reviewed the coupler situation as it had been presented to the railways during the past year. It concluded with a series of recommendations, most of which simply called for minor changes in the general dimensions of couplers. The committee also made a report on draft gear. This report, like that on couplers, concluded with a series of recommendations for changes in the dimensions of the present draft gear standards of the Association. The discussion which followed the report was quite long. It turned very largely upon the design of the yoke for twin spring draft gear which was recommended by the committee. The discussion concluded with a motion that the coupler committee should contiue its work and that a special committee should be appointed to act in conjunction with it and with the manufacturers for the purpose of deciding upon a standard form of M. C. B. coupler.

LOADING LONG MATERIALS.—The committee on this subject presented a majority and minority report, but before the convention was over the majority and minority members met and effected a compromise; so that at the last day of the convention an amended report was presented which was signed by the entire committee. The report as presented suggested a large number of changes in the present M. C. B. rule for loading long materials. There was no discussion of the report, and upon motion it was ordered to be sent out for approval by letter ballot.

TRUCK ARCH BARS.—This committee was appointed to design truck arch bars for 100,000-lb. capacity freight cars. Realizing the wide difference in opinion of railway mechanical men as to the proper size and form of arch bar, the committee sent out circulars of inquiry to determine, if possible, present practices in these respects. Answers were received from fourteen railways, and based upon them the committee drew the following conclusions and recommended that they be adopted by the Association:

(1) Distance between wheel centers to be 5 ft. 6 ins.
(2) The cross-section of the top and inverted arch bars to be 6 × 1¼ ins.
(3) The section of tie bar to be 5 × ⅝ ins.
(4) The inverted arch bar to be gibbed, to provide a bearing for each end of the top arch bar.
(5) The tie bars to be gibbed at the ends.
(6) The set of the top arch bar to be 3⅞ ins.
(7) The distance between the top and inverted arch bars to be 19¼ ins.
(8) The set of the inverted arch bar to be 15⅜ ins.
(9) The set of the tie bar to be 3⅜ ins.
(10) The distance from center to center of column bolt holes to be 16½ ins.
(11) All column and journal box bolt holes to be 1-16 in. larger than the diameters of the bolts.
(12) The distance between the top of the track rails and the bottom of the tie bar to be 6⅝ ins.
(13) The distance between the top of the track rails and the lower end of the column bolts to be not less than 4⅜ ins.
(14) The diameter of the column bolts to be 1¾ ins., and these bolts to be fitted with combined washers and nut locks at the head of the bolt and at the nut, and with the United States standard square heads and nuts; the top arch bar to have the column bolt holes countersunk on the upper side, to take a ¼-in. radius filler under the head of the column bolt.
(15) The radii at the bends of the top arch bar to be 2 ins., and of the inverted arch bar at the column castings 2¼ ins.
(16) The radii of the inverted arch bar at the journal box to be 2¼ ins.
(17) All other dimensions to conform to the present M. C. B. standards.
(18) The material preferable for arch and tie bars and column bolts is good wrought iron, this being better able to withstand distortion without detail or entire fracture.

Notwithstanding the rather revolutionary suggestion that the material to be used for truck arch bars should be wrought iron instead of steel, this report received practically no discussion from the members present. The recommendations of the report were ordered to be submitted to letter ballot by vote of the convention.

SAFETY APPLIANCES.—This committee was appointed to report on three questions: First, the design for a ladder; second, proper location of the ladder; third, proper location of hand holds on the roof of cars. The report presented was as follows:

Cars with projecting end sills: That one ladder be located at each end of car about 16 ins. from center of car to center of ladder, the ladder sides to be made of hard wood and to be not less than 1½ ins. by 4¼ ins., the bottoms to rest on end sill or end sill plank and to be secured with not less than three ⅝-in. bolts on each side, the ladder to be not less than 18 ins. wide and to have at least 4 ins. clearance between the ends of the car and the steps, the number of steps to be such that the maximum distance from center to center of steps shall not exceed 15 ins. The steps, if of wood, to be not less than 1½ ins. by 2 ins., with the corners chamfered and let into the sides and secured by ⅝-in. button head bolts; for iron steps, the iron to be not less than ½ in. diameter, and to be secured by not less than ½-in. bolts.

For cars not having projecting end sills, we recommend that the ladders be located on the end of the car, in accordance with the present M. C. B. standard, ladders to be made in the manner given above.

For roof hand hold, we would recommend that a hand hold not less than 11 ins. or over 22 ins. from center to center, made of ⅝-in. round iron, flattened at ends, and secured to the roof of the car by four ⅝-in. bolts, and with wrought iron washer under roof board when secured to roof boards only; when secured to roof framing one ½-in. bolt at each end may be used, the grab iron to be located crosswise of the car not less than 7 ins. from the edge of the roof board and immediately over each ladder.

It is the opinion of your committee that on account of the reduced clearance with the wide cars, while running or standing on adjacent tracks, either main tracks or in yards, that the end ladder is preferable to the side ladder.

The discussion which followed the report was very brief. The general tenor of it was that, as the report was presented in manuscript form, and the members of the Association had not had an opportunity to read it and consider the full meaning of the recommendations, no action should be taken by the convention except that of simply receiving the report and ordering it to be printed in the Proceedings of the Association.

STEAM LINE CONNECTIONS.—This committee, which was appointed in 1904 to continue experiments and submit detail dimensions for steam heat hose couplings reported that it had held a number of meetings during the year, at which representatives of the various car heating companies appeared and expressed their views. After obtaining all the information of this character that they could, the committee was endeavoring to harmonize the differences in design and was making fair progress in this work. It was not, however, ready to submit a complete report at the present time, particularly in view of the progress being made in the development of automatic couplings for steam heat and air-brake hose. In view of the great promise of automatic hose couplings, the committee suggested that it should be discharged and that a new committee should be appointed to consider specifically the question of automatic hose couplings, and, if possible, to report a standard form of automatic coupling for adoption by the Association. There was no discussion on the report. Upon motion the convention voted to discharge the present committee and to appoint a new committee to consider the subject of automatic hose couplings.

TANK CARS.—The committee on this subject had prepared no formal report, but Mr. A. W. Gibbs (Penn.) stated orally that the committee was making progress in its work. There was no discussion on the report.

STENCILING CARS.—The report of this committee may be summarized by quoting the following recommendations made by it:

First. It is recommended that the Roman letters and figures of the designs shown in the attached drawings be adopted for uniform stenciling of freight cars.

Second. It is recommended that the sizes of these letters and figures shall be confined to the following heights: 1 inch, 2 inches, 3 inches, 4 inches, 7 inches and 9 inches.

Third. It is recommended that 7-inch or 9-inch letters or figures be adopted for the initials or name and numbers for the sides of cars, and 4-inch letters or figures for the same markings on the doors and ends.

Fourth. It is recommended that for other car-body markings on sides and ends, such as capacity, couplers, brake beams, class of car, date built, outside dimensions, inside dimensions and markings inside of car, 2-inch or 3-inch letters and figures be used, with the following exceptions:

1. All weight marks should be 3-inch or 4-inch letters or figures.

2. Trust marks, patent marks, and other private marks, should be 1-inch letters and figures.

Fifth. It is recommended that all marks on trucks should be confined to 1-inch and 2-inch letters or figures.

Sixth. It is recommended that stenciling on air-brake cylinders or reservoirs should be 1-inch letters or figures.

In presenting the report, the chairman of the committee stated that he had conferred with the Master Painters' Association and that the recommendations which had been made were entirely in harmony with the views of that Association. The report was not discussed and it was ordered by vote of the convention to be referred to letter ballot for adoption as recommended practice.

COUPLING CHAINS.—This committee presented drawings for two safety chains for chaining together cars carrying double loads. It also said:

Your committee believes that something better than this permanent safety chain can be designed in the way of fixtures for application to freight cars for auxiliary couplings, and recommends that a new committee be appointed to work this out, or the present committee continued for this same purpose.

The convention voted to submit the chains shown to letter ballot as recommended practice, and also to continue the committee another year.

DRAFT GEAR.—The report of this committee was as follows:

Referring to the matter of drawbar side clearance, which was referred to your committee, the committee would recommend that the 1-in. total side clearance shown on M. C. B. Sheet "B" be increased to 2¼ ins. total clearance. Would also recommend that experiments be made to determine how much more clearance can be safely used without the use of a centering device. In view of the fact that the work of the Draft Gear Committee is now so closely allied with that of the Coupler Committee, it does not seem that there is any use to continue the Draft Gear Committee under present conditions. If it is not the desire of the Association that the committee should take up the question of testing new designs, as was done several years ago, or improvement in old designs, it would probably be well to discharge this committee or merge it with the Coupler Committee.

There was very little discussion on the report. It was voted to submit the recommended clearance dimensions to letter ballot for adoption and also to continue the committee, with instructions to confer with the committee on couplers.

CAST IRON WHEELS.—The work of this committee was confined to drawing up a uniform guarantee for cast iron car wheels. This work was requested of the Association by the Wheel Makers' Association in May, 1905, and the committee had time only to receive the suggested guarantee proposed by the wheel makers and to present it to the convention in the present report. The proposed guarantee and the reasons urged by the Wheel Makers' Association for its adoption are as follows:

The manufacturers of cast iron chilled car wheels, having submitted to your committee the proposed schedule of guarantee, beg to give herewith the reasons for the various conditions contained therein:

TIME GUARANTEE, FREIGHT CAR SERVICE.

33-in. wheel, 60,000-pound capacity cars, 4 to 6 years.
33-in. wheel, 80,000-pound capacity cars, 3 to 4 years.
33-in. wheel, 100,000-pound capacity cars, 2 to 3 years.

As the period of guaranteed service for wheels under cars of 60,000 pounds capacity has been arrived at from general practice as being the term of four to six years, the guaranteed mileage has been reduced proportionately on account of the increase in loads carried and general service conditions.

GUARANTEE ON WHEELS FOR PASSENGER AND REFRIGERATOR CAR SERVICE.

36-in. wheels, 35,000 to 75,000 miles.
33-in. wheels, 30,000 to 60,000 miles.

When time guarantees are given, the guarantee is to expire at the end of one year, provided the guaranteed mileage has not been made before.

GUARANTEE ON FAST FREIGHT SERVICE.

33-in. wheels to be guaranteed for one year.

ENGINE TRUCK AND TENDER SERVICE.

36-in. wheel, 35,000 to 65,000 miles.
33-in. wheel, 30,000 to 60,000 miles.
30-in. wheel, 25,000 to 55,000 miles.
28-in. wheel, 20,000 to 50,000 miles.
26-in. wheel, 20,000 to 45,000 miles.

All wheels used in engine truck and tender service to have the guarantee expire at the end of one year, provided that the guaranteed mileage has not been made before that time.

The guarantee as indicated for the 60,000-lbs. capacity cars is the same as exists at the present time, and is as has existed for some years past.

The variation in the number of years and mileage guarantee is intended to cover the case of railroads using sand ballast, this variation being the same as used in present practice.

The guarantee of three to four years on cars of 80,000 lbs. capacity and two to three years on cars of 100,000 lbs. capacity is based on the comparative increase in loads carried and general conditions of service, which conditions obtain without corresponding increase in wearing surface of wheels.

CAUSES FOR WHICH WHEELS SHOULD NOT BE REPLACED.

Wheels removed on account of longitudinal seams at flange or broken flange not caused by defective material or manufacture.

Longitudinal seams are not inherent defects in wheels and never exist in wheels before same are put in service. This defect is caused by the excessive heat generated by wear of flange against rail and excessive application of brakes.

Broken flanges when not caused by defective material or manufacture are not failures under control of wheel maker and therefore should not be replaced.

Slid flat and chipped flanges.

Present practice does not call for replacement of wheels removed on account of slid flat and chipped flanges, therefore no change is made in this respect.

Wheels removed on account of thin or worn flanges, not due to lack of chill, and mates for such wheels not to be replaced.

It is not the general practice to replace wheels removed on account of thin or worn flanges when such failure is not due to lack of chill. This defect is caused by conditions beyond the control of wheel makers and such wheels should therefore not be replaced.

When wheels are removed on account of hollow tread, being mates for wheels taken out on account of thin or worn flanges, such defect not being caused by lack of chill, such removals are due to conditions beyond the control of wheel maker and should not be replaced.

Broken or chipped rim not caused by rim being hollow.

It is not the general practice to replace wheels removed on account of this defect, therefore no change is made in this respect.

Breakage of any kind caused by wreck or derailment.

It is not the general practice to replace wheels removed on account of this defect, therefore no change is made in this respect.

Shelled treads occurring in pairs on the same axle when shell spot occur opposite each other.

Shell treads occurring in pairs on same axles when shell spots occur opposite each other and without raised spots in the center are due to causes arising from the use of brakes, which causes are beyond the control of wheel makers and therefore such wheels should not be replaced. As it is not the general practice to replace such wheels at present, no change is made in this respect.

Wheels removed on account of worn tread before wear on tread exceeds ⅜ in. in depth, unless found on examination that the wheel is worn through chill.

This condition is made to provide for wheels being removed only after proper wear has been obtained from the same.

Wheels furnished in replacement to be marked "R" and all such wheels to be exempted from further guarantees. Wheels failing for causes attributable to manufacture to be held for twenty days for inspection or returned to the manufacturer for examination. An exception will be made in case of wheels removed on foreign roads for which a charge of $2 will be made in settlement and particulars in evidence of failures furnished.

The Wheel Makers' Committee also submitted the following facts for consideration in connection with the increased service demands under cars of large capacity:

COMPARISON OF CAR WHEELS PAST AND PRESENT AND THEIR CONSTRUCTION AND REQUIREMENTS OF SERVICE AS PRESENTED AT THE CLEVELAND MEETING.

Capacity of car. Pounds.	M. C. B. standard finished wheel fit. Ins.	Cubical area.	Weight of wheel in common use. Pounds.
24,000	4¼ x 7	13,364	525
28,000	4¼ x 7	13,364	550
40,000	4¾ x 7	18,685	580
50,000	5¼ x 7	20,689	500
60,000	5¾ x 7	22,690	600
80,000	6¾ x 7	31,909	625
100,000	6¾ x 7	37,122	650

COMPARISON OF 12-TON CAPACITY EQUIPMENT WITH 50-TON CAPACITY EQUIPMENT.

	Per cent.
Increase in cubic area, finished wheel fit	177
Increased weight of rails	100
Increased weight of wheels	23
Increase in load capacity:	Pounds.
Formerly 24,000 pounds, now 100,000 pounds	76,000
Increase in tare weight of car:	
Formerly 18,000 pounds, now 28,000 pounds	10,000
Increase in permitted excess load (10 per cent.):	
Formerly 2,400 pounds, now 10,000 pounds	7,600
Total additional load	93,600
	or 375 per cent.
Increase in time guarantee (2 years to 4 and 5 years)	125 per cent.
Increase in annual mileage of cars	100 per cent.
Total increased requirements of our wheels	600 per cent.

It will be noted from the above table that the service requirements of the chilled iron car wheels have been increased 600 per cent. in service that can be positively calculated, and that this fixed increased demand of service must be supplemented by the indefinable increase in requirements caused by the difference in the effect of brake action on grades and the side thrust on flanges of wheels in rounding curves, or overcoming the loss of elasticity and individual freedom of cars, resulting from the use of self-couplers; and the further additional effect of all these causes by the great increase in the speed of trains.

Attention is also called to the fact that the flanges of the iron wheels have no increase at all, due entirely to track conditions that would not permit it, but nevertheless wheel flanges are called upon to stand a positive increase of 600 per cent. in measured service, and practically all of the increase in the indefinable service referred to previously.

It will be noted, as indicated by the largely increased dimensions of the axles and rail, that it has been found necessary to compensate for the increased requirement of service, not only by increasing the weight, but also by the substitution of better materials, as, for illustration, the use of steel in rails and axles in place of wrought iron.

It will be seen from the above that the work on the car wheel per mile and per year has been abnormally increased. What wears out the wheel is the load ton per mile. A 40-ton car traveling 1 mile puts double the work on a wheel compared to a 20-ton car traveling 1 mile; a car making 20,000 miles per year puts double the work per year on a wheel compared with 10,000 miles per year. All guarantees were originally given in proportion to the work done per mile or per year; as the work per mile and per year has been more than double, the guarantee should at least be cut in two to give the same relative comparison.

Furthermore at the request of your committee, the Wheel Makers' Committee after the meeting submitted the following general conditions and reasons for urging the adoption of a uniform guarantee:

Referring to the form of guarantee which has been adopted by car wheel manufacturers, and presented to you at the Cleveland meeting on May 31, and to your request for reasons why this guarantee should be accepted by the M. C. B. Association, the following is respectfully submitted:

To provide uniform guarantee and replacement terms, the M. C. B. Association having no recommended practice to cover the same, excepting to the extent that this question has been touched upon in rules of interchange. These rules were for heavy capacity cars, and other more severe conditions that did not prevail to the present extent in the past.

To insure to railroads a form of guarantee that will be uniform and give the maximum amount of service that can be safely guaranteed, and to provide a reasonable variation in the case of railroads operated under conditions that shorten the life of wheels for causes beyond control.

To correct the prevailing hardships and injustice imposed upon car wheel makers by the varying and in most cases excessive guarantees exacted by the railroads. For instance: Granted that the six-year guarantee for 30-ton cars is a reasonable one, the 70% increase on loads for 50-ton cars, with absolutely no increase or change in tread of wheel, certainly calls for a decrease in the terms of guarantee. All that is asked for is a square deal.

Service guarantee for 33-in. wheels have been based for many years on a mileage of 60,000 miles and a time guarantee of three to six years, and the causes for which wheels have been replaced have been those which were due to defects attributable to manufacture. In other words, defects for which the wheel maker could not be properly held responsible.

There has always been a disposition on the part of some railways to secure, if possible, a longer period of service and a more general replacement of wheels removed from service. The object to be obtained by such increase in guarantees and replacements was naturally to reduce the cost of wheel service, and the effect was exactly the same as if lower prices had been paid for new wheels.

The heavy increase in loads carried and consequent wear and strain on car wheels that has taken place in late years has intensified all conditions of service and developed new and more difficult ones, which increase heavily the duty imposed on car wheels.

While the use of heavy car and locomotive equipment has necessarily been attended by new conditions, intensifying the results of service, and while these new conditions have no doubt received careful attention from railway officials, it is nevertheless true that the brunt of the increased hardship of service has fallen on the car wheel, and that the latter has been compelled to stand in the breach while the various details of equipment were being brought to a proper order of practice.

It is plain that the conditions of car wheel service have been more than doubled in intensity under such heavy equipment, and that the use of the latter is now becoming so general as to call for prompt action to the end that guarantee conditions be made comparative with service conditions.

Wheel makers, however, do know that the present guarantee conditions are absolutely impossible, and that in the case of many railways there is a positive loss on all orders taken. Also that these conditions are extending from month to month from one railway to another, and that the general conditions, bad as they are at the present time, are sure to become much harder.

With the form of guarantee submitted to you is a brief statement setting forth the reasons why the changes proposed are necessary, and it will be noted that in a considerable number of general guarantee conditions, no changes are made. In the very important matter of test conditions no change is requested, although the increase that has taken place in such test conditions in late years has imposed a situation on the wheel makers for which there has been no adequate additional compensation in price paid for wheels.

Generally speaking, the wheel makers, from the point of absolute necessity have been compelled to bring this whole matter before the M. C. B. Association to the end that the co-operation of that body might be secured to ameliorate the conditions now prevailing, which are believed to be as much against the true interests of railways as against those of the wheel makers.

It is the desire of the latter to give proper and fair guarantees and to make good failures for which makers are responsible, but it is nevertheless necessary to recognize present and increasing service conditions, and to make such changes as will compensate for them, and leave the wheel makers in a position where they can conduct their business in a proper way and fulfill guarantees that are given.

The need for prompt action in this matter arises from the rapid changes that have been made in the weight of equipment, and the conditions which from month to month are becoming more evident, as to the results obtained from wheels that have been put under such class of equipment.

The necessity for prompt action in this matter is also due to the impossible nature of present conditions, and if you will therefore give serious consideration to the whole subject, as represented at the Cleveland meeting, the wheel makers of the country will appreciate such action on the part of your committee and of the association.

The discussion on this report was quite long and turned largely upon the best method of conducting further investigation. It was finally decided to continue the committee, with instructions to consider changing the present wheel contour and to confer with the committee of the American Railway Association in respect to the contour of the wheel in relation to the track.

TOPICAL DISCUSSIONS.

SALT WATER DRIPPINGS.—The topical discussion on this question was opened by Mr. C. A. Schroyer (Chicago & Nwn Ry.), who said:

A short time ago our chief engineer brought up the subject with the mechanical department on our line regarding methods for preventing the discharge of salt brine along the road, which he has found rusts the splice bars, the bolts and nuts and the filling blocks on cars and other metal parts of bridges, etc. He thought that it was something we should go into very carefully, and I at once addressed a circular letter at some length to the heads of the mechanical departments of the different roads, requesting them to advise us what experience they have had in that line. I found almost invariably where the matter has been submitted to the engineering department that there is more or less trouble occasioned on all the railroads from the rusting of these parts caused by the salt brine discharged from the dressed beef refrigerator cars. I asked in that circular to what extent this trouble existed, but not many of the roads were in position to say to just what extent it existed, nor do we ourselves know, but it is like many other things in railroad practice—we know it is occurring, but to just what extent we do not know. We feel that something should be done to prevent that damage to the track and the iron structure on the roadway.

I have had interviews with the dressed beef refrigerator lines on the subject, but they have done nothing to prevent this except to carry out the former practice of the M. C. B. Association in which they put a pipe from the inside of the car leading down from the center of the track and discharged the water or meltage from the ice on the center of the track between the truck frame. That was done on the recommendation of this association to avoid rusting of the arch bar bolts and of the oil boxes, but in doing that we never gave thought to the destruction of the track and the bridge structures.

We find the difficulty exists to a large extent where the train stops at crossings or switches and the jerking and motion of the cars is increased because of these conditions. I asked the refrigerator companies if they ever considered anything to prevent this. They have not, so far as I have been able to find out, but the thought which occurred to me was that it would be possible for us to construct a car having an auxiliary tank for the storage of the brine, constructing it in such a way as to allow the water resulting from the melting of the ice to drop down into that tank, having the tank of sufficient size to hold enough water to carry the car from one terminal to another, and having arrangements at each terminal so that the water could ge discharged in such a way as to avoid destruction to the track. There is nothing else I can say to the association on this subject; but I believe we should do something in our dressed beef refrigerator cars whereby the water from the melting ice could be carried in the car a sufficient length of time and at stated intervals discharged by means of valves or otherwise.

Mr. W. E. Symonds—Inasmuch as steel underframing is coming into general use in car construction, I would suggest the advisability of the scope of the work of such a committee being enlarged. I think any formal investigation which may be made into this subject should include also the effect on car bodies as well as the permanent way, the tracks, bridges, frogs, etc. I think it is quite essential that it should be included and followed up.

CAST IRON WHEEL FLANGE BREAKAGE.—The topical discussion on the question, "How does the M. C. B. cast iron car wheel show up in service as regards the breakage of flanges?" was opened by Mr. R. L. Ettinger (C. M. E., So.), as follows:

The 1904 cast iron wheel has not been in service long enough to state that the design is perfect and will remedy all defects in former patterns, or was it claimed by the Committee presenting it that they believed it to be the only design that would give good, satisfactory service; but the 1904 wheel was presented as the best they had to offer by a very representative committee of this association, ably assisted by a committee representing a majority of the largest wheel makers in the United States. These manufacturers must be satisfied that they are on the right track, as I have recently heard from a number who are now prepared to furnish this design, one writing that the 700-pound pattern was made shortly after the convention last year and a great many thousand wheels from it put under cars of 100,000 pounds capacity and from which they have had practically no complaint.

The companies with which I am connected put 8,000 wheels from this design in service last winter under 100,000-lb. steel coal cars. These cars are operating on some very heavy grades, and up to the present time we have not had any failures. Of the lighter wheels for 60,000-lb. cars we have a large number running.

One of the most interesting things in this line I have heard of happened on a road in the West. They had a number of very high coal cars that were giving a lot of trouble breaking wheels, and it was decided to try the new M. C. B. design. The wheels were changed under some 200 cars, and I am told that none of the new wheels has failed. In this same connection and leading up to the change there were some tests made at Purdue University of types of wheels in general service and wheels made from the new M. C. B. pattern. All of the results were in favor of the new design, but as the gentlemen who conducted that test are here I will leave it to them to tell about it.

After being asked to open this subject I tried to get what information I could, and in reply to numerous inquiries the replies have indicated that those who had the new wheel in service were satisfied that this association had made no mistake.

I believe, however, that the opinion is getting to be universal that the breaking of flanges will be reduced to a minimum for cast iron wheels by the addition of ¼ in. more metal on the outside. This increase will amount to but little more than 1-16 in. on a line with the wheel tread, and while this will not affect guard rails set at 1¾ any more than a driving wheel, the common distance of 53¼ between flanges, or a car wheel and rail that have a combined wear of 1-16, the co-operation of our road departments could very rapidly bring about the same relative conditions that now exist.

On going into this question very carefully with our engineering department we could not find any objection from their point of view to making the change in the wheel and using them on the tracks as now laid, or on their part to increasing the clearance between main and guard rails to 1⅞ ins. on all new or repair work, and this has been decided on.

We took this matter up with our engineering department with some hesitancy, because there had been so much said about the objections we might expect to meet with but in place of objections found a perfect willingness and desire in that department to do anything the mechanical department asked with the view of better wheel service and fewer failures. I believe with this one change, and the necessary change in wheel gages, we would have as good a wheel as can be designed in cast iron.

Mr. George L. Fowler—I have not had the privilege of having charge of any cars of 100,000 lbs. capacity using cast iron wheels, but I have been commissioned on two or three occasions to look into the service of cast iron wheels under various conditions, and I find the most delightful condition of uncertainty prevailing throughout the whole railroad community. If any of you get into lawsuits in regard to the safety of cast iron wheels, I can give you expert testimony on any line that you want. I can tell you the names of men who will say that the cast iron wheel under 100,000-lb. capacity cars is perfectly safe on the worst kinds of lines, mountain lines, crooked and everything else, and we run the whole gamut from that right down through the railroad men until we find a condition where they are exceedingly doubtful as to the feasibility of putting a cast iron wheel under a car of 100,000 lbs. capacity. In other words, we are now going right straight through what has been repeated time out of mind in the proceedings of this association in times past. There have been innumerable things that have come before this association and the Master Mechanics' Association which, before they have been developed, have shown that there was great uncertainty, and we have not yet come to the final conclusion. The position, as it seems to me that it stands today, is that there is an uncertainty in regard to the advisability and the safety of using a cast iron wheel under a car of 100,000 lbs. capacity. Under a 60,000-lb. capacity car there is no doubt whatever but that it is all right. Under an 80,000-lb. car they seem to think that it is just about on the verge of the upper limit. With regard to the 100,000-lb., the general sentiment as I find it through the community is one of doubt. They want a better wheel than they have now. In two recent articles printed in the "Railroad Gazette" and the "Railway Age," together with the wheelmaker's desire for a change in the guarantee, we find this same thing embodied. One author writing in the Gazette says that if you will only pay more for your wheel you will get a better wheel. The Age and the report of the Wheelmakers' Association advocate the lowering of the guarantee, which means, probably, that the wheel as it is used to-day under a 100,000-lb. car is being strained beyond its powers of endurance, and, therefore, like any other metal that is being strained beyond its elastic limit, its life is shortened accordingly. Of course, nothing has been said in regard to the attempts that have been made to remedy these defects. Changes have been made in brackets, in the location of the plates and the thickness of the metal, in order to strengthen the wheel, and as has been said in opening this discussion, these have been to a certain extent successful, but there have been a number of cracks, and some very peculiar cracks, developed in action on mountain roads, and it has been found that the brake action in heating the wheel is apt to produce an internal crack that no inspector can see, and it works its way to the outside, but in detail looking as though there were an inherent defect in the wheel that came from the foundry, whereas in reality it appeared due to the brake action, because the same thing has been reproduced by subjecting a wheel to a thermal test, not the thermal test with a thick band of metal, but with a thermal test of about ¼ in., just heating it about as the brake shoes would heat it, and producing an internal crack which cannot be seen by any kind of an inspection.

Now with regard to the strength of the cast iron wheel, I think we are all in the dark. In the last few months I have inquired sedulously of every man that I have met if he knew anything at all about the strength of chilled cast iron and I can find no tests in regard to the matter. The result is I am going to make them myself and find out. But there have been some tests made, and I expected it would be referred to in the opening of the discussion in regard to the strength of a flange of a cast iron wheel. Professor Goss of Purdue some time ago took some cast iron wheels and put them in his testing machine, laid them flat and put a square pressure bar down against the flange, holding it in place so that it could not back off with some rollers and push the flange down off the wheel. He told me the other day that a normal wheel broke at 70,000 lbs. pressure. I heard of this a few weeks ago, and I thought I would like to corroborate those figures for myself and try to see what the relative strength was of a steel tired wheel or a steel wheel. I wrote Professor Goss asking him if he thought that he could do the work on his testing machine, and he calculated that it ought to take about four times or four and a half times as much pressure to push off the steel flange as a cast iron flange. Basing my calculation on a comparative tensile strength of the metal, which for cast iron wheels runs from 28,000 to 30,000 lbs. and for steel tire runs from 112,000 to 125,000, I made some tests a short time ago of the tensile strength of tires and I found that they broke at about 112,000 or 113,000. Taking similar tests of specimens from the tread of the Schoen steel wheel, with which you are all familiar, probably, it broke at stresses ranging from 118,000 to 123,000; so that there is not much difference between the two.

Professor Goss said he was unable to do that work in his machine, so I requested the Schoen Steel Wheel Company to lend me their press, which has 1,000 tons capacity, to do the work. I got the wheel that the makers knew I was going to use for that purpose, and they sent me one that was a little thicker on the flange than the law really allows, and the chill was very decidedly less than you would care to accept. I think the chill measured about ⅛ in. in the throat. I had good solid gray iron in behind there to stand the stress. My figures on that are not, of course, absolutely accurate, because I was working on a large press where I had to allow for the weight of the head and also for the frictional resistance of the backing, but the frictional resistance of the backing has been pretty thoroughly worked out and there is probably not much error in my figures. This is not the same method that Professor Goss [illegible] I broke the flange off of that chilled iron wheel at [illegible] sure of 116,000 lbs. The flange of the Schoen steel wheel broke at 526,000 lbs., showing that there is not very much difference in the relative value of the strength of the flanges or in the relative value of the tensile strength of the metal that was in the [illegible] In the case of the cast iron wheel under consideration I did not measure the tensile strength. I had no time for that.

The question comes up as to what you are doing with your wheels. I do not think there is anybody [illegible] knows anything at all—if he does he has kept it himself most thoroughly—anything at all about what the stresses are that are put on a wheel. I have tried carefully to find out what the load is that is put on a wheel both vertically and horizontally, and at the present time I am engaged in an investigation to ascertain what the vertical stresses are on a wheel, and I would say that we are very much in the condition of a man who would attempt to build a bridge without knowing anything about the load that the bridge was going to carry. You are running your wheels at all kinds of velocities with all kinds of loads, over all kinds of track, and there is no one that knows anything at all about what the actual flange stresses are. If the flange of a cast iron wheel is only worth 70,000 lbs., which Professor Goss tells me is the normal stress, it looks to me as though we were running very near the danger line when we are running cars of [illegible],000 lbs. capacity, high, as these cars are loaded, away up higher than the old box car used to be, and over all kinds of curves, without knowing what those loads are. I would suggest that it would be a very appropriate thing for this association to investigate what the horizontal stresses are on a wheel when it is in motion.

MALLEABLE IRON FOR WEARING SURFACES.—The topical discussion on the subject, "Is it Advisable to Use Malleable Iron for Wearing Surfaces?" was opened in writing by Mr. Foque.

The use of malleable iron for wearing surfaces has been somewhat limited, but a general answer to the question would be, No. Owing to the softness of the metal, the abrasion is very marked and harder iron has longer life. This can readily be seen in passenger car journal boxes where after a few months' service holes are worn through the sides of the boxes, and such surfaces are now protected by steel wearing strips. For parts subjected to a lesser degree of motion, such as center plates, side bearings or draft gear, malleable iron will prove satisfactory if properly designed, care being taken to so proportion the wearing surfaces as to keep the load per unit of surface and the friction within safe limits. In conclusion, while malleable iron may furnish a fairly satisfactory wearing surface under favorable conditions, the general tendency is to restrict its use to purposes for which, as a substitute for cast iron, its greater strength makes it particularly valuable.

TWO IMPORTANT NEW STATE DEPARTMENTS IN PENNSYLVANIA.

Two important State departments were created by the last Legislature of Pennsylvania—a State Water Supply Commission and a State Department of Health. Through the kindness of Messrs. Birkinbine and Dixon, mentioned below, we are enabled to give the following particulars regarding these departments:

THE WATER SUPPLY COMMISSION OF PENNSYLVANIA is composed of five members, including the State Commissioners of Forestry and Health. On June 20 Governor Pennypacker named the three other members of the commission as follows: John Birkinbine, M. Am. Soc. M. E., Consulting Engineer, Broad and Cherry streets, Philadelphia; John F. Wentworth, Corporation Clerk, Pennsylvania State Department of Kittaning, Pa.; and Henry M. Brackenridge, of Pittsburg. Dr. Samuel G. Dixon was recently appointed, State Commissioner of Health, and by virtue of that office will be a member of the water commission. The ex-officio members serve on the water commission without compensation other than expenses; the other three men are to be paid $3,000 a year, and are authorized to "appoint a competent engineer" at a salary of $2,500 a year, and a combined clerk and stenographer at $1,200 a year. The three appointed members are to serve four years each, and vacancies are to be filled by the Governor for four years. The duties of the commission are

to procure, as speedily as may be, all the data and facts necessary to advise them thoroughly of the situation of the water supply of the State, and adopt such ways and means of utilizing, conserving, purifying, and distributing such water supplies in such a way that the various communities of the State shall be fairly and equitably dealt with in such distribution: Provided, however, that the local distribution of water within the limits of an incorporated village, town or city is not to fall within the jurisdiction of this Commission.

The commission is also to report annually on the conditions of the water supply of the State,

recommending such future legislation as in its opinion is necessary for the conservation, development, purification, equitable distribution, and supply of the waters of the State, and in particular to such communities as are now greatly in need of extended facilities for this purpose.

Hereafter no charters can be issue dto water

companies operating within the State until the applications for the same are approved by the Water Supply Commission. An appropriation of $40,000 has been made for the salaries and other expenses of the commission.

THE PENNSYLVANIA DEPARTMENT OF HEALTH, which supersedes the old State Board of Health, is now being organized for active work under a statute passed by the last Legislature. The department consists of a highly salaried ($10,000 a year) single commissioner and an unpaid advisory board of six members—five physicians and one civil engineer. The State is to be divided into ten health districts each in charge of a physician of five years' standing at a salary of $2,500 a year. These district physicians, it is said, will not be appointed at present. The commission appears to be given extensive powers for carrying on work of sanitation and quarantine. The Commissioner of Health, recently appointed by Governor Pennypacker, is Dr. Samuel G. Dixon, President of the Academy of Natural Sciences, 1300 Arch street, Philadelphia. Dr. Dixon was born in 1851. After having been admitted to the bar, he studied medicine at the University of Pennsylvania, then went abroad for the study of bacteriology, spending some time in Pettenkofer's Laboratory of Hygiene at Munich. In 1888 he was appointed professor of hygiene in the medical and scientific departments of the University of Pennsylvania and dean of the department of medicine. In 1889 he resigned, in order to take up private research in bacteriology at the Academy of Natural Sciences. He was subsequently made curator, and, in 1896, president of the Academy. Dr. Dixon has appointed as Assistant Commissioner, Dr. Benj. Lee, for many years Secretary of the State Board of Health, and has chosen as his Secretary Wilbur Morse, a Harvard graduate. Dr. Frederick G. Johnson, of Bradford, has been chosen as Chief of the Division of Inspecting, Quarantining and Disinfecting. The advisory board has been named by Governor Pennypacker as follows: Dr. Samuel G. Dixon, Dr. Samuel T. Davis, President of the former State Board of Health, of Lancaster County; Dr. Leonard Pearson, of Philadelphia, State Veterinarian and Veterinary Lecturer at the University of Pennsylvania; Dr. Adolph Koenig, of Pittsburg, President of the Pennsylvania State Medical Society and editor of the Pennsylvania State Medical Journal; Dr. B. H. Warren, of Westchester, Pennsylvania Dairy and Food Commissioner; Dr. Chas. B. Penrose, of Philadelphia; and Lee Masterson, of Johnstown, Civil Engineer. The formal office of the Department of Health is at Harrisburg, but there will be a "branch office" at 1900 Arch street, Philadelphia, where, we understand, Dr. Dixon will be found, and where the meetings of the Advisory Board will be held. Dr. Dixon will be the presiding officer of this board and will have a vote upon questions that come before it. As stated above, Dr. Dixon is an ex-officio member of the new State Water Supply Commission.

100,000-LB. CAPACITY CARS are not likely to be exceeded in capacity in general freight service for a long time to come. Two principal reasons for this were explained as follows by Mr. C. A. Seley, Mechanical Engineer of the Chicago, Rock Island & Pacific Ry., in a recent address at Purdue University:

One reason is that the concentrated weight on the adjacent trucks of two 50-ton cars coupled is as great as a very heavy engine load. Freight cars are generally allowed 10% excess lading over their marked capacity, and this amounts on a 50-ton car to a total of 110,000 lbs. Adding 40,000 lbs. for the dead weight makes a total of 150,000 lbs. There are many consolidation engines that do not exceed the above weight on their eight drivers; hence the common cast-iron wheels used under these 100,000-lb. cars carry as much weight as many an engine driver, and when concentrated on a short bridge span give an equally heavy load. The second reason is that cast-iron wheels seem to have about reached their safe limit of their strength in carrying 50-ton cars. It does not seem feasible nor advisable to increase the number of wheels under a freight car, and so far, no substitute has been developed that can take the place of the cast-iron wheel at a reasonable cost. All forms of built-up wheels with steel tires cost several times as much as cast-iron wheels, and, furthermore, no railroad has a tool equipment with which to turn off and keep in order such wheels for their freight equipment. It is very likely that the future will develop a wheel, cast or rolled from steel, that will have a tire of such density and hardness as to give a mileage that will justify its higher price and the necessity for scrapping it after making such mileage instead of turning or retiring it.

The vital point in the cast-iron wheel is the flange. We cannot thicken it or add supports on account of being restricted by necessary clearance in frogs and crossings. The braking power of 50-ton cars is high and on long grades the wheels become highly heated and are then cooled, perhaps suddenly. The consequent expansions and contractions may develop fine cracks at the root of the flange and in time weaken the flange. These cracks close and are almost invisible when the wheels are cold and thus escape detection. They are very much in evidence, however, when a piece of the flange drops off in going through a frog or on a heavy curve. This development has caused much concern to the railways and as much as anything else has stopped a further increase in the capacity of general service cars.

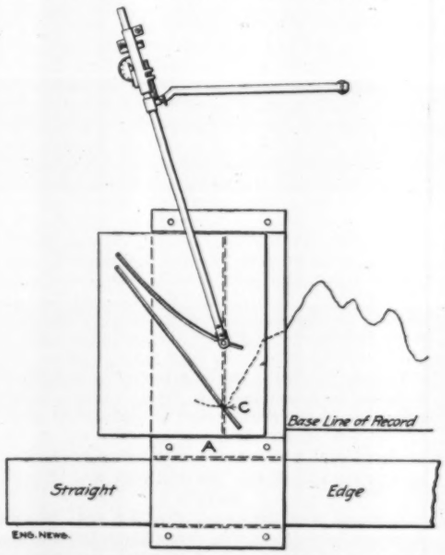
STEAM RAILWAY MOTOR CARS have recently been built at the shops of the Great Central Ry., of England, to the designs of Mr. J. G. Robinson, Chief Mechanical Engineer. The car is mounted on trucks, the first one being a driving truck and carrying a vertical boiler which is enclosed within the car body. The cylinders are outside, and the Walschaert valve gear is used. The car is 61 ft. 6 ins. long, and can seat 12 first class and 44 third class passengers (there is no "second class"). At one end is the engine compartment, followed by a baggage compartment and a first-class passenger compartment. A transverse entrance gangway at the middle has doors opening to the first-class compartment in front and the second-class compartment at the rear, while at the rear end is a small compartment for the engineman to occupy when the car is running backward. The car is fitted with electric light, steam heat and automatic vacuum brake.

A DEVICE FOR AVERAGING CERTAIN KINDS OF CONTINUOUS RECORDS BY THE PLANIMETER.

By W. L. Butcher,* Assoc. M. Am. Soc. C. E.

Engineers connected with offices pursuing investigations extending over a considerable period of time are often confronted with the laborious task of averaging and reducing to a useful form masses of accumulated data. Among such material some of the most common items are continuous records showing the heights of water above the crest of a weir. The task of finding a daily average flow from these indicated depths is quite a long one. It consists, generally, in dividing the diagram by vertical lines into spaces representing short intervals of time, and in reading the heights at each of these verticals. The flow corresponding to each must then be found and the results averaged.

The application of the planimeter to this problem for the purpose of facilitating the work is shown in the accompanying sketch. The device



A Device for Averaging Certain Kinds of Continuous Records by the Planimeter.

is one which can be readily made in the office. It consists simply of two sheets of transparent celluloid. The lower one, marked A, is constrained by means of narrow strips riveted to its under side to slide in a horizontal direction along the fixed straight edge, and has a narrow vertical slit cut in it, as shown. The upper sheet, which is also prevented from moving in any but a horizontal direction, contains two slits, as indicated. The curved slit is plotted on the sheet so as to indicate for a 1-ft. weir the flow in cubic feet per second for any depth shown by the corresponding ordinate of the lower slit, at a point vertically below. The scale and zero point are chosen so that the curve may assume a position somewhat as indicated on the sketch. On inserting a tracing point at C and moving it along the line of the diagram it will be seen that the point of the planimeter constantly assumes a position representing the number of cubic feet per second for the depth given directly below. It remains simply to trace around the area of the diagram, divide by the length of the diagram, and multiply by the length of the weir, to obtain an ordinate which represents the average flow.

It is perhaps needless to say that the device is actuated solely by the tracing point, the operation being no different than when the planimeter alone is used.

*Cambridge, Mass.

ANNUAL CONVENTION OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The thirty-seventh annual convention of the society was held at Cleveland, O., June 20 to 23, the headquarters and place of meeting being at the Hollenden Hotel. The convention was largely attended, and was generally successful and enjoyable, although the weather was somewhat oppressive for a part of the time. For some years past the society has held its conventions at pleasure resorts, away from the crowding and rush of city hotels, and on this occasion there was a certain amount of dissatisfaction, due to the scattering of members at various hotels, and the general confusion necessarily incident to holding a convention of nearly 600 persons in a busy city. The total number of members and guests registered was 576.

The opening meeting was called to order about 10.30 a. m. on June 20 by the President, Mr. C. C. Schneider. A brief opening address of welcome on behalf of the local members was delivered by Mr. August Mordecai, of the Erie Railway, in which he stated that since Cleveland abounded in examples of engineering work and enterprise, and since it was originally founded by a party of civil engineers under the direction of Gen. Moses Cleaveland in 1796, it was a specially appropriate place of meeting for the American Society of Civil Engineers. He reviewed its municipal and industrial development, and referred to some of the prominent men (engineers and others) which it has produced. An address of welcome on behalf of the city was delivered (owing to the absence of the Mayor) by Rev. H. R. Cooley, Director of the Board of Public Service, who laid special stress upon the fact that much of the work of the engineer is for the welfare of the people, rich and poor alike, as exemplified by great water supply and sewerage systems for cities, and by railways and many lines of industrial enterprise. A response to this address was made by Mr. C. C. Schneider, President of the society.

The business of the society was then taken up and the members at once began discussion of the proposal to establish local organizations or chapters of the society in different cities. This subject occupied the attention of the meeting for the whole morning and the discussion was continued on June 22. A report of the discussion is given further on.

In the evening Mr. C. C. Schneider gave the annual presidential address, taking as his subject the development of bridge engineering. This address was published in our last issue.

There were no papers presented at this meeting and no technical subjects for discussion.

The report on the place of the next meeting showed the usual wide range, but Duluth had a majority of votes. It was voted by the meeting, as usual, that the whole matter should be referred to the Board of Direction, with power to act; the resolution, however, contained the suggestion that the Board should endeavor to select a summer resort and (if possible) one having a hotel of sufficient capacity to accommodate all attending members and guests.

By unanimous vote a resolution of sympathy was tendered to Messrs. S. T. Wellman and John W. Seaver, of the Wellman-Seaver-Morgan Co., in the loss sustained by the deaths of Mr. Charles H. Wellman and Mr. Thomas R. Morgan in the

railway accident on the Lake Shore & Michigan Southern Railway, June 21. A resolution expressing regret at the absence, through illness, of the Secretary, Mr. C. W. Hunt, was also passed; as was also a vote of thanks to him for his successful work in connection with the International Engineering Congress and the publication of its proceedings. There was also a hearty vote of thanks to the local members and committees for the entertainment provided and numerous courtesies shown to the visitors.

ORGANIZATION OF LOCAL ASSOCIATIONS.

In opening the discussion on this subject, a statement issued by the Board of Direction was read by the Assistant Secretary, Mr. McMinn, owing to the absence (through sickness) of the Secretary, Mr. Hunt. This idea of establishing local associations or chapters as branches of the society has been brought up at various times, and was revived recently through the proposal of the members at Washington, D. C., to establish such a local association. The Board of Direction has therefore brought the whole matter to the attention of the members, and in a printed statement of its views has recommended that such associations should be formed. According to this statement the papers presented to the society could be discussed at meetings in various localities, the non-resident members would be in closer touch with the work of the society, and there would be no interference with exising local engineering societies or clubs. It may be noted here however, that all these points were strongly disputed when the matter was discussed in the meeting. The board sent its statement to certain members in 14 cities; at two of these (Kansas City and San Francisco) local associations have been organized; at the others the matter is under consideration or has been disapproved.

The discussion indicated a general opinion that while local associations of members may be established with advantage in places where no local engineering association already exists, they would not be successful where the latter do exist, and would in fact be detrimental. The discussion was opened by Mr. John C. Trautwine, Jr., who thought that the proposed associations would weaken and conflict with local societies, but he suggested that the latter might be taken in as chapters of the society, under a special grade of membership. Mr. G. S. Davison, of Pittsburg, representing the Engineers' Society of Western Pennsylvania, stated that the American Society has 122 members in and around Pittsburg, 60 of whom are also members of the local society; half of these latter are active in the affairs of the local society, while very few of the other 62 members are active in the affairs of the American Society. The general opinion of the Pittsburg members was that a local association for the members of the American Society was not desirable. The same opinion was expressed in a letter from the Chicago members of the American Society, whose opinion had been requested. Mr. Oberlin Smith approved of local chapters of some kind, but admitted that there seemed to be no enthusiasm over the matter, perhaps because the proper plan had not yet been suggested. He did not approve of any new grades of membership. Mr. G. A. Ricker, of Buffalo, remarked that with a local society the admission was made easy in order to obtain enough members to make the society financially successful, and to admit all these as members of the American Society would lower the standing of the latter. He believed that local chapters of the latter would benefit local members and reflect credit on the parent society.

Mr. Geo. Y. Wisner said that it was the unanimous opinion at Detroit that a local chapter would be impracticable; three attempts have been made to organize a chapter, but all have failed. There is now a local society with 160 members, and a local chapter of the American Society would probably be a failure in itself and break up the existing society. The local members of the American Society form but a small part of the membership of a local society, and unless lower grades of membership are adopted by the American Society it could not take in all the members of a local society. Mr. B. R. Green, of Washington, approved of local chapters, more for social purposes than for the reading of papers, and the same idea was presented by Col. P. C. Hains. One member suggested that the local societies might be taken in as chapters, and the members become "chapter members," without becoming actual members of the American Society, but it was pointed out by others that the public (and the profession) might assume the term "member" to imply actual membership, which might lead to unpleasant results. Mr. Hunter McDonald, of Nashville, stated that in 1889, he and eight other members of the American Society, desiring a closer social organization, formed what is now the Engineering Association of the South. This now covers a large part of the Southern States, and has "sections" at Nashville and Birmingham. A local "chapter" of the American Society would be antagonistic and he did not believe such chapters should be formed where local societies exist.

Mr. J. J. R. Croes remarked that any engineer (civil, mechanical, mining, electrical, etc.,) is eligible for membership in the American Society of Civil Engineers if he has the necessary qualifications in personal character and professional character. He must have acquired something in the way of knowledge and have done something in the way of work. Membership in the Society stands for something accomplished and the ability to accomplish something more. In places where there are a number of members it would be well to organize them for social intercourse, and the interchange of ideas and information, rather than for the formal reading of papers. But engineers who were not qualified for membership or have not troubled to obtain membership in the American Society should not be included in the local associations. Otherwise the main object would be lost. The formation of these associations should be entirely optional with the local members, and should be confined exclusively to members of the American Society. These last two basic ideas met with general approval and at the close of the discussion the meeting adopted a resolution approving the several suggestions of the Board of Direction in favor of the organization of local associations of the members.

SELECTION OF MEMBERS TO SERVE ON PUBLIC COMMISSIONS.

At the annual meeting held in New York in January, a resolution was passed requesting the Board of Direction to consider the propriety and advisability of the Society making recommendations or nominations from among its members (or others) to serve on technical commissions or to render special professional services. A report from the Board was submitted. This report reviewed the scope and purpose of the Society, and showed that one of its principles is to keep clear of personal matters. Papers dealing with personal interests are not accepted, and responsibility for the opinion expressed in papers is distinctly disavowed. If it were understood that such nominations could be made, strong influences, both inside and outside, would be exerted. The conclusion of the report was that such nominations did not belong within the scope of the Society and should not be made. On motion of Mr. James Owen, the report was accepted and adopted, the vote being unanimous.

INTERNATIONAL ENGINEERING CONGRESS.

A report was presented showing that the six volumes containing the proceedings of the Engineering Congress at St. Louis last year have all been published and distributed. They comprise 96 papers and 398 papers and discussions, these being by 283 persons of 18 nationalities. The total cost has been $35,000, and $3,858 has been received from the sale of the volumes. Mr. Robert Moore spoke of the exhibits secured by the Society, and stated that the collection had been awarded a "grand prize," being the highest grade of award. A diploma will be given to the Society, and copies of this given to each individual contributing to the exhibit. An appropriation of $8,000 was made by the Society for the purpose of the exhibit, but only $6,800 were spent.

ENGINEERING AND INDUSTRIAL FEATURES OF CLEVELAND.

On June 21 there was a short session in the morning, with W. A. Mordecai, of the local committee, in the chair. Addresses were made by some of the Cleveland members. Col. D. C. Kingman, U. S. A., spoke of the Cleveland harbor, its engineering and transportation features, and called attention specially to the inadequate railway facilities of the harbor, which condition has been one cause for the establishment of other harbors in the vicinity. He predicted that the city would adopt the policy of owning all the harbor, dock and shipping facilities, in the interest of the port and the city. Mr. W. J. Carter, City Engineer, outlined some of the engineering features of the city; its large water tunnel under the lake, its intercepting sewer, the bridges and viaducts (including swing drawbridges and Scherzer and Cowing bascule bridges) the paving and also the traveling roadway recently described in our columns. Mr. Alexander E. Brown, of the Brown Hoisting Machinery Co., described the conditions which led to the development of the Brown ore handling machinery and also described the company's new plant, which has buildings of steel frame construction, with walls and roof of "ferro-inclave," a reinforced concrete of his invention. Sheets of steel are pressed to shape with dovetailed corrugations and are imbedded in concrete, the total thickness being 1¼ ins.

Mr. Harry Fuller made a brief reference to the plant of the King Bridge Co., covering 20 acres, and having an annual capacity of 25,000 to 30,000 tons. Prof. C. S. Howe, of the Case School of Applied Science, dealt with technical education in Cleveland, and at the Case Institution in particular. In the erection of one of the new buildings the plan has been adopted of testing full-sized beams instead of test specimens from these beams. With 12-in. beams of 15 ft. 9 ins. span, the weight per foot has been found to be 5% less than that given in the handbooks. Among the features of the laboratory is a new plant for testing the drawbar pull of automobiles.

These addresses were continued on June 22, when Mr. C. S. Brush, the electrical engineer, dealt with the important part which Cleveland has played in electrical developments: the telephone, arc lighting, storage batteries, and traction. Mr. Hill of the commission which is in charge of the project for a grouping of the new public buildings, explained this project, which appears likely to be carried out. Land will be purchased for a large public square, extending for two or three blocks, upon which will front the city hall, county building, public library, new union station, etc. That part of the land not required for public buildings will be sold, but under restrictions as to the class of buildings to be erected by the purchaser.

EXCURSIONS AND ENTERTAINMENTS.

In the afternoon of June 20 there was a long carriage drive through Euclid avenue and the parks to the Garfield memorial and then to the house of the Country Club, on the lake shore, where the party spent about an hour. The next afternoon carriages were provided for a visit to the works of the Brown Hoisting Machinery Co. and the King Bridge Co., and then to the Case School of Applied Science. A stop was made at the Roadside Club, where refreshments were served. The third afternoon was left for the members to visit such places or plants as they chose, carriages and other facilities being provided. There was a musical entertainment at the hotel in the evening of June 21, followed by dancing; and on June 22 there was a formal reception at the Chamber of Commerce Hall.

On June 23 there was a steamboat excursion to Lorain, the steamer leaving at 9.30 a. m. A short stop was made at the Lorain plant of the American Shipbuilding Co. to see a 500-ft. ore steamer under construction and nearly ready for launching. About two hours were then spent in inspecting the ore handling plant, blast furnaces, rolling mill, etc., of the National Tube Co. The party then returned to Cleveland arriving about 5.30 p. m., and thus ended the convention.

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The serious disaster at Mentor, Ohio, on June 21, by which the new 18-hour express train between New York and Chicago was wrecked, and more than a score of persons were crushed and burned to death, raises a serious question as to whether these extraordinary high train speeds are justified.

Of course it is true that an ordinary passenger train would have suffered wreck had it been in the place of the 18-hour flyer; and various railway operating officials are quoted to the effect that the risk of accident is no greater on a fast train than on a slow one. Such an opinion, however, is contrary to common-sense. Risk of disaster is actually increased with every increase in train speeds; and when disaster does occur to a high-speed train, either in the form of derailment or collision, its results are likely to be far more serious than would be the case if the train were running at low speed.

Particularly is it true that danger is involved in an increase of train speeds over that at which express trains are ordinarily run, or say an increase from 50 miles an hour to 70 miles per hour. Since the stored energy in a moving body varies as the square of its velocity, a train at 70 miles an hour contains nearly double the stored energy of one travelling 50 miles an hour; and as a consequence if danger appears ahead and the brakes are applied, the 70-mile an hour train will run twice as far before stopping as the 50-mile an hour train.

The movements of all high-speed trains are governed by signals, and these signals are located with a view to their use by trains of ordinary express speeds. A train running at much higher speed may not receive the signal's warning in time to stop before reaching the danger point.

Again, as every railway engineer knows, the superelevation of the outside rail on curves is a compromise between what is demanded for ordinary freight speeds and ordinary passenger speeds. The higher we raise the speeds of exceptionally fast trains, the greater the unbalanced centrifugal force on curves and the more serious the shocks and strains on rolling stock and track. It is perfectly well known that for high-speed running, easy curvature is essential, and the engine runner on a fast express train is supposed to know the road so that he can slacken speed at points where any exceptionally sharp curves occur. But when the man in the cab has to make up time, he is very apt to "take chances," and sometimes it happens that he takes one chance too many.

If the running of exceptionally high-speed trains were really of large public benefit, it might be urged that the increased risk of accident was worth while; but we are strongly of the opinion that these high-speed trains actually cost the railways, directly and indirectly, far more than they return in increased revenue. It is well known, of course, that to run a train at an average speed of say 60 miles per hour, the number of cars must be cut down to three to five, as compared with perhaps double that number on a regular express train. Nearly all those who travel on the 18-hour or 20-hour trains would travel on the ordinary trains if the faster train were not available. All the railway gains, then, by its high-speed trains is the fares of a few who are led to travel by the novelty of riding on a record-beater, plus the increase over the ordinary fare which is paid by passengers on the high-speed train.

We believe if the actual total cost of these high-speed trains were carefully determined, it would be found to be far in excess of any possible return in additional revenue. In computing this cost there should be taken into consideration the interference with other traffic, an exceedingly important matter on the trunk line roads with their enormous volume of freight. As is pretty well known, it is freight traffic that pays profits on American railways. A large proportion of American passenger traffic barely pays the expense of moving it. The railways must provide good passenger service, of course; but they are not obliged to furnish it at a loss, and the endeavor ought always to be to make each class of traffic pay at least its own fair share of revenue.

It may be claimed by some enthusiast that the reduction of the New York-Chicago time to 18 hours is a public benefit and that the railways ought to furnish 18-hour trains, therefore, even if they are not profitable. But if such fast trains are a convenience to the public at all commensurate with their cost, then the public ought to be willing to pay for them. If the fares on the 18-hour flyers were raised to a point which would cover the full cost of the service, we are inclined to the belief that there would not be passengers enough to nearly fill the trains, and the railway company would find the fast service still unprofitable.

There is still another aspect of the high-speed train that deserves a word of notice here, and that is the effect of example. The New York Central and Pennsylvania set the pace; and a good many other railway companies are likely to attempt to follow it to the extent of speeding up their crack trains to a faster schedule. As noted above, we have no commendation for this latest time reduction on these trunk line roads; but they are better equipped to run trains safely at 70 miles an hour than some other roads at 50 miles an hour.

The great defect of American railroading today is not low speeds. It is too frequent accidents. Most American railway trains are run at quite as high speed as the existing track, rolling stock and signal systems justify. If money is to be spent for improved service, let it be in making travel safer. So far as increased speed is concerned, the traveling public as a whole will gain much more by greater promptness and regularity of train movement and close adherence to time tables than it will by spectacular feats of fast running by special trains.

The actions and published opinions of the New York Central and Lake Shore officials with reference to high-speed trains betray decided differences of opinion. Immediately after the accident President Newman was reported as declaring that all fast express trains run at too high speed for safety, and that high-speed trains were only run to satisfy the public demand, railway officials, as a rule, preferring slower—and safer—schedules for their trains. At the same time public announcement was made that the 18-hour trains between New York and Chicago over the Vanderbilt lines would be discontinued.

The officials of the Lake Shore & Michigan Southern R. R., however, took the opposite position from President Newman; defended the high-speed service and, in view of the fact that the train was running at only ordinary express speed when the wreck at Mentor occurred, argued that the accident would have happened to any other fast passenger train under the same circumstances. Their opinions and arguments (coupled doubtless with the fact that the Pennsylvania lines gave no sign of abandoning their 18-hour train) appear to have prevailed, for on June 26 announcement was made that the 18-hour service over the Vanderbilt roads would be restored.

The Mentor disaster will not be without good results to offset in some part its appalling total of death and suffering if in addition to serving as a warning against the dangers of excessive speeds, it shall induce greater efforts toward the abolition of facing point switches on double-track roads. That such switches should be avoided is pretty well known to engineers; and on a few roads, such as the main line of the Pennsylvania and the Boston & Albany, facing-point switches are extremely few. But on many other roads, considerations of convenience in daily operation are allowed to outweigh the matter of safety to fast trains. Of course it can hardly be said that the facing-point switch is so dangerous that it should never be permitted; for all main-line switches on single-track roads are facing-point switches for trains in one direction or the other; and the great bulk of railway mileage the world over is single-track lines. All that can reasonably be said is that on double-track railways, running fast passenger trains, facing-point switches should be avoided, and avoided even at the expense of considerable trouble and inconvenience.

The annual meeting of railway motive power officials—the Master Mechanics and Master Car Builders—held at Manhattan Beach recently as reported in this and the preceding issue of Engineering News was particularly noteworthy for the large attendance and the high character of the work done. Altogether nearly two score of formal papers and reports were discussed. It was not to be expected, of course that each of these papers and reports should reach high-water mark in length and merit, but enough of them did this to give the conventions good claim for leaving the stock of information about railway motive power matters considerably increased. The conventions took very important action in several matters, and for the first time in several years the report of the Arbitration Committee on disputes relating to the interchange of cars aroused more than perfunctory discussion.

While not primarily an engineering question, the dispute on which the Arbitration Committee rendered decision is so far-reaching in its effect and so unusual that a word or two in explanation is justified. The case in question arose from the refusal of the Missouri Pacific R. R. to pay for a Pennsylvania R. R. car destroyed at Kansas City at the time of the disastrous flood of June, 1903. The argument of the Missouri Pacific R. R. in support the refusal to obey the rule of the Master Car Builders' Association, which says, "railroad companies handling cares are responsible for damage done to any car by unfair usage, derailment or accident," was that the flood in question was an act of Providence, to which it contributed in no way and for which it can in no way be held responsible. Under the clause of the Interchange Rules quoted above and the further clause that "the decision of the Arbitration Committee shall be final and binding upon the parties concerned," the Arbitration Committee rendered decision that no exception could be taken in the present case and that the rules should stand as they are. This decision was supported by the vote of the convention. As the matter now stands the Missouri Pacific R. R. refuses to abide by the decision of the body which it with other railways formally contracted should be the final arbiter in the disputes arising between them as to the interpretation of the rules governing their interchange of traffic.

It is beyond the scope of this journal to discuss the legal aspects of the question at issue, but a precedent has been established in disputing the authority of the Master Car Builders' Association in question relating to the interchange of railway

traffic that may easily lead to deplorable results.

In many respects the most important matter considered at the convention of the Master Mechanics' Association was the use of super-heaters on locomotives. The paper by Mr. H. H. Vaughan, Superintendent of Motive Power of the Canadian Pacific Ry., on this subject was of great practical value. This paper was printed nearly in full in our issue of June 15, and it is unnecessary to repeat the details here. Briefly stated, the experience of the Canadian Pacific Ry. with super-heaters leads them to conclude that their use results in a saving of some 10 per cent. in fuel consumption. So few other roads have had experience with locomotive superheaters that the discussion added very little information to that given in the paper. Another year is likely to bring about a change in this respect since a number of roads in the United States are now conducting experiments, whose results will be available within a few months.

In the Master Car Builders' proceedings particular attention is demanded by the discussion on car wheels. There is considerable dispute whether or not cast iron wheels are sufficiently strong and durable for 100,000-lb. cars, certainly the present cast iron wheel is not giving entire satisfaction. The result of the convention's deliberations was the appointment of a committee to review the whole subject of wheel design, especially for heavy cars.

Another action taken by the association was the reference to a committee the task of designing a standard coupler combining the best features of all the present patented couplers. The idea in mind is that the various patentees shall pool their issues, and that all manufacturers shall be permitted to make the new composite coupler.

Elsewhere in this issue a description is given of some of the features of the new works of the Ingersoll-Sergeant Drill Co. In the operation of this plant a very complete system of cost records is kept, and, as far as possible, the piece-work system is employed. Even the work of the messenger boys is recorded in such a way as to inspire them with interest in their work. When a workman at any one of the numerous machines wishes to exchange tools, he presses a button that summons a boy. But before the boy leaves the messenger station he picks up a card and stamps the time of his departure in the proper place on the face of the card. An electric time stamp, made by the American Clock Co., of Chicago, is used for stamping the time to the nearest minute, at the same time recording the day of the month and the year. There are four spaces on the card marked respectively thus: Messenger No. — started to answer at ....; No. — section called at ....; Messenger returned to Tool Department at ....; Tools delivered at .... The time of the messenger's arrival at each place is stamped in the proper place. On the rear of the same card the workman writes his number and his requisition. All these cards are kept, and at the end of each week the number of trips made by each messenger boy is bulletined. The brightest and most active of the boys are the first to be promoted from the messenger service to the machine shop or elsewhere in the plant. It occurs to us that there are certain kinds of contract work in which the time stamp could also be used to advantage for recording work done, with a view to increasing the output.

A REAPPEARANCE OF THE NARROW GAGE FALLACY

We have frequently called attention in these columns to the dearth of literature relating to light railway construction and operation. Elsewhere in this issue we reprint a paper recently read before the Chicago Branch of the American Institute of Electrical Engineers which has the suggestive title "Light Electric Railways."

The author of the paper, Mr. Jas. R. Cravath, correctly sets forth the demand for railways which can be built and operated cheaply enough to live and pay a profit from the traffic furnished by farming districts and small villages. Without doubt, as he says, the present type of electric interurban railway can only prove permanently profitable where a good sized traffic can be secured. In fact, the probabilities are that a not inconsiderable mileage of electric railways have been built during the last half dozen years which will never pay anything like a fair rate of interest on the money invested to build and equip them.

What Mr. Cravath sets out to do in his paper is to plan a type of electric railway which can live and thrive on gross earnings of $1,500 to $2,000 per mile per annum, and he describes a hypothetical railway system which he thinks could be built and equipped for about $8,000 per mile as compared with $20,000 to $25,000 per mile for standard electric railway construction.

So far Mr. Cravath's paper merits hearty praise. Engineers will agree with him, moreover, when he says that in order to make a low cost railway for light traffic we must adopt light rolling stock and moderate speeds. But when he proposes to solve the problem by adopting a narrow-gage, one can only express surprise that at this day a defender of the hoary old narrow-gage delusion should still be found.

The narrow-gage fallacy all centers round the idea that the cost of building a railway is in proportion to its gage. Mr. Cravath says:

> Narrow-gage railways have fallen into disrepute among railway engineers and with good reason, because the ordinary narrow-gage road does not differ sufficiently in cost from a standard-gage road to make the saving worth while in most cases. If we go into the narrow-gage business, we must go far enough to gain some substantial advantage. It is, therefore, suggested that a road of about 28-in. gage has the decided advantage of greatly reduced cost of construction.

With singular blindness, Mr. Cravath then proceeds to set forth how he will save in cost of rolling stock, in cost of rails, in cost of ties, in cost of grading, etc., because his gage is only half that of the standard gage; and he wholly fails to perceive that the economies he enumerates are made possible by his light-weight rolling stock and low speeds and that the gage has nothing to do with it at all.

We earnestly advise Mr. Cravath, or any one else who becomes infected with the narrow-gage fallacy to carefully read the chapter on "Light Rails and Light Railways," in Wellington's "Economic Theory of Railway Location." While it was written with reference to steam roads, it is equally applicable to electric railways, so far as gage is concerned. It was shown in that chapter that the narrow gage saves nothing in cost of rolling stock. On the contrary, light-weight cars on locomotives for light traffic can be built more easily and cheaply for standard-gage tracks than for narrow gage. Bridges, trestles and tunnels are not at all affected by the gage. The size and weight of rolling stock govern in their design, and, as just stated, small and light cars can be built as well for standard gage as for narrow gage. Fencing, right of way, buildings, frogs, switches, signals, side-tracks, shops, etc., are not affected at all by the gage. Neither is the cost of the electric part of the equipment, such as poles, wires, insulators, rail bonds, etc.

Absolutely the only saving by the narrow gage over the standard, therefore, is a slight saving in the grading for the roadbed and in the ties. "The ties" (to quote from Wellington) "may be made somewhat shorter, or about three-quarters of the usual width; but only at the expense of decreasing the stability of the track and increasing the labor required." As for the grading, it is true that a cut or fill may be made narrower by the width of the gage; thus, if a roadbed with a standard top width of 9 ft. at subgrade is assumed, by adopting a 28-in. gage this could be reduced to, say, 7 ft., which would reduce the total cross-section of a cut or a fill by perhaps 10%. Thus the total saving due to the adoption of a narrow gage for a light railway, "is only 1% to 4% of the entire cost of the line's construction," to quote again from Wellington's treatise.

To offset even this trifling saving, we have the undoubted fact that *to keep the track maintained to a given standard more labor must be expended on a narrow-gage road than on standard gage* Particularly is this the case with such a very narrow gage as that proposed by Mr. Cravath. The reason for this is that a given inequality on narrow-gage track has much more lurching effect on a car than the same inequality on standard-gage track. This fact even affects to some extent the matter of weight of rail. We ordinarily assume the weight of a car to be equally distributed to the two rails of the track; but in lurching over rough track and in passing around sharp curves at varying rates of speed, the actual fact is that one rail carries much more than half of the load. This is the case even with standard gage, and it is much more the case with a gage so narrow as 28 inches.

But on railways handling light traffic it is exceedingly important to keep down the expense for track maintenance. It is the fixed charges on bonds and the cost of keeping the track in safe running condition that forms the millstone around the neck of a railway company struggling to make a living out of light traffic. It is absolutely necessary to permit the tracks to go unsurfaced for long periods at a time; and the point we want to emphasize is that the standard gage will stand such neglect much better than the narrow gage.

The question of narrow gage vs. standard gage is of particular interest at this time because in the specifications for the new Philippine Government railways, recently made public, the gage is fixed at 3 ft. 6 ins., although it is announced that alternate bids for standard gage lines will be received and considered.

Of course it is true that very satisfactory railways can be built and operated on the 42-in. gage, and such a system would undoubtedly have all the traffic capacity necessary for the Philippines; but we are strongly of the opinion that there is absolutely no advantage in the narrow gage to justify its adoption there, and that it will cost as much or more to build, equip and operate as the standard gage. In other words, the real gain in economy in the narrow gage is not at all due to the gage but to the light rolling stock and permanent way. If equally light cars and locomotives are used on a standard-gage track, it can be built and maintained, we believe, at less total cost, on the whole, than a narrow gage road.

For many years the fallacy persisted that the narraw-gage system was particularly adapted to mountainous counties because sharp curvature could be used more freely. The fallacy of this was also shown up by Wellington twenty years ago; but since his day practical experience in electric railway construction has proved even more conclusively that a standard-gage road can be built with as sharp curvature as any locating engineer would desire, provided only that speeds be reduced to correspond. Further, for a given speed of trains the standard-gage has the advantage over the narrow gage on sharp curves, that the cars will lurch less because of the broader support.

How completely Mr. Cravath falls into the error above explained may be seen by the following quotation:

> With a road of this kind operating at slow speed on a narrow gage, it would be good engineering to avoid many of the cuts and fills that would be necessary on a high-speed road and to pick a location which goes round hills rather than through them. What would be considered a very crooked route for a standard gage steam road would be unobjectionable on a light railway of this kind.

This is admirable engineering for light railway construction, and Mr. Cravath only needs to learn that he can do it as well and better with a standard gage construction.

Leaving now the question of gage, it will be of interest for a moment to consider Mr. Cravath's estimates of cost and inquire whether it is possible to cut down the cost to such a figure as he claims.

In the first place such light traffic railways as he proposes might ordinarily be laid along country roads. The general public benefit of such railways and the small profit obtainable from them will usually justify the giving of a franchise. Moreover, with electric traction and low speeds, there will be very little objection to placing such a line on a country road, particularly as it will usually be placed at one side of the traveled highway and not directly upon it. Under these conditions the cost of grading may in favorable lo-

cities be brought even below the figure assured by Mr. Cravath. On the other hand, Mr. Cravath's attempt to save in first cost by reducing weight of rails would be certain to prove a penny-wise economy in the long run. It would only cost about $700 per mile more to lay 40-lb. rails instead of the 30-lb., which he assumes, and the saving in cost of track maintenance and increased life of the rails, would make this increased outlay practically mandatory. Mr. Cravath's 4 × 6-in. ties would be dear as a gift. We do not mean to say that it would be at all necessary to use first class full size railway ties on a light-traffic road with such light rolling stock as is here proposed; but instead of his 20-ct. tie, 4 × 6 ins. and 4 ft. long, a tie large enough to cost at least 30 to 40 cts. (and probably the latter figure), should be provided in most localities to obtain reasonably substantial construction.

Without attempting further criticism in detail of Mr. Cravath's estimates of first cost, let us turn to his estimates of operating expenses. He assumes that his hypothetical road could be operated for a total outlay of only $765 per mile per annum, of which nearly $500 goes for electric current and wages of motormen and conductors. He assumes *only* $90 *per mile per annum* as the cost of maintaining both the track and the overhead work. Any engineer familiar with practical track work will see at once that these figures are wide of the mark. By no possibility can the cost of the road work alone be brought down anywhere near this figure. Ties rot and heave with frost just the same whether one car a day or one hundred pass over the road, and therefore to base the estimate for maintenance of way on the car miles run is the height of absurdity.

We shall not take space further to criticise in detail Mr. Cravath's estimates, save to briefly refer to his omission to make adequate allowance for cost of superintendence and accounting, etc. We do wish, however, to point out the fundamental error in his plan for operation, since it is one too often repeated by managers of electric railway lines. Briefly stated, Mr. Cravath assumes an hourly service on his proposed road and thus rolls up an expense account which would be the financial ruin of the enterprise, when other necessary expenses were paid.

The way to operate a light traffic road economically is to limit the train service. Of course, not quite as much traffic will be secured with trains run only twice or three times a day as with trains run every hour; but on a light traffic road, nine times out of ten, the additional traffic will cost much more to obtain than it will yield in revenue. On a light traffic road all attempt to follow out the street railway idea of frequent cars should be abandoned and instead the cars should be run by time-table and should follow it as closely as a steam railway train.

The question of the relative economy of steam or electric traction for light traffic lines is one that invites discussion, but time and space forbids it here. We may, however, point out the single fact that while Mr. Cravath fixes $3,000 to $4,000 per mile as the necessary amount of annual gross earnings to make an electric interurban railway pay, there are many thousand miles of railway in this country operated by steam locomotives on which gross earnings per mile per annum fall below $3,000, which are yet able to pay their operating expenses and enough at least of the charges on cost of construction to keep out of a receiver's hands.

LETTERS TO THE EDITOR.

Concerning Mechanical Stokers.

Sir: Referring to the editorial in your issue of June 15, relative to mechanical stokers, I do not think criticism should be directed to the stoker in general, because if stokers were properly designed, there could be no question about their successful operation. It would be more advantageous for improvement and development to take place along legitimate lines, rather than that radical changes be advocated. When it is taken into consideration that one fireman has produced 8,000 kilowatts on the switchboard, this fact compels us to respect the stoker machine. This performance has been recorded, and by one fireman. I mean that one exclusively manipulated the fires.

It has frequently been urged that stokers are not suitable for small plants, and comparison has been made between them and hand fired grates under conditions of careful manipulation, with the result that in a very large number of instances the hand firing has shown superior results; but this is not the true measure; it is the service condition which interests the user, and it is my experience that hand fired methods in every day practice fail to approach the ideal in a very much greater measure than does stoker performance. I have been able to watch performance in large plants which ran 24 hours a day, and by comparing results of monthly and yearly performance, I found that in the same service, stoker performance was better than that of a variety of hand firing methods. In my endeavor to secure careful and proper manipulation of hand fires, especially with coals high in ash, I have been forced at times to the conclusion that it would pay to use some form of stoker which would cause the uniformity of coal feed and ash removal, which should be but is not obtainable from the men carrying out the hand firing method, notwithstanding that the coal would have to be shoveled into the machine.

This matter is a very complicated one and the greatest difficulty is, that the engineers endeavoring to work out a solution are not sufficiently familiar with the fuel. As a rule, they are ignorant particularly of its physical characteristics, mining conditions, etc. Also, our practice is very largely influenced by engineers who are located in eastern states adjacent to the Appalachian coal fields, and who are familiar with a fuel very different from that available in states further west. For example, conclusions arrived at by using semi-bituminous coal with 2 or 3% ash in it on hand fired grates, can give an engineer little or no data, having an application to coals of an entirely different proximate composition and containing very many times more ash. When it is taken into consideration that in Illinois, for example, under a good sized boiler, about 3,000 pounds of coal should be burned per hour, and that this fuel is necessarily screenings which may contain 20% ash, it must at once be realized that this is not an attractive hand fired proposition.

Very truly yours,

A. Bement.

215 Dearborn St., Chicago, June 20, 1905.

The Reinforced Concrete Warehouse at Minneapolis.

In the article in Engineering News of June 8, 1905, entitled "A Reinforced Concrete Warehouse for Northwest Knitting Company," the writer speaks of his work as a novelty. Whether western engineers have failed to grasp modern ideas in this kind of construction, I do not know; but I do know that the design, as shown and described in the article referred to, is by no means novel. In the first place, the idea of bending hooks at right angles to the axis of strain is an old one, tried years ago on the Continent and discarded in all first-class design. In this country the Illinois Steel Company made some very extensive tests on this same design, and proved its lack of value beyond the shadow of a doubt.

Again, the design as shown for beams allows for nearly twice as much strength for direct bending as for longitudinal shear. This is an unpardonable error now that this feature of design has been brought down to an intelligent basis.

In the cut, Fig. 2, showing the floor reinforcement, the rods that should be parallel and were meant to be placed parallel are in places crossed, giving the floor one-half the strength designed at that point. Many of the rods are bent, and apparently thrown, hit or miss, into position.

Another novelty spoken of is the treatment of continuous beams over supports. This treatment has been used for years by eastern engineers.

The idea of unit column reinforcement has been carried out by nearly every company in the business to-day. The Considere column reinforcement is a unit that has been on the market for years.

As for the use of a rich and exceptionally wet concrete, I would like to ask who ever heard of any one using anything else for a first-class reinforced concrete job.

The climax of the whole article comes at the end, where it says this system is patented. Will some one kindly let us know what the patents cover, and if they are not old enough to soon be renewed?

A Concrete Man.

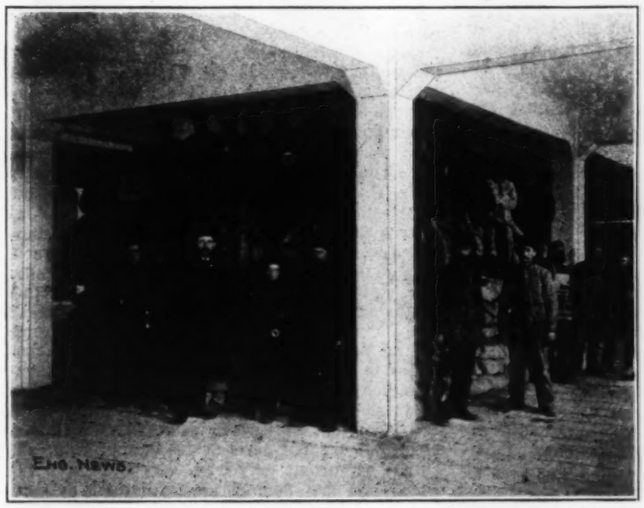
Pittsburg, Pa., June 12, 1905.

(Proof of the above letter was submitted to the engineer who designed the building referred to, and his reply is appended.—Ed.)

Sir: I have received proof of criticism, modestly signed, "a concrete man" of an article you wrote based on drawings furnished you by the writer. The writer admires the gentleman's good taste in concealing his identity particularly in view of the general character of his criticism. It reminds him somewhat of the report of two engineers on a building failure that he was called upon to investigate in Iowa. These gentlemen, by assuming the accuracy of certain theories (never demonstrated) of eccentric stress, figured that the failure occurred through the collapse of compression members of the truss which under test of duplicate members with identical connections showed a strength four times as great as that which they had calculated they failed under!

The difficulty in this case was with the walls supporting the truss and not with the truss. The critic contends that the rods where crossed were not intended to be placed in that position, basing his assumption no doubt on the practice of many designers of reinforced concrete, following, or imitating the old style of wood and steel construction, putting in beams two or three times as closely as economy would warrant.

As regards the strength of construction the writer will only answer that it has been subjected to a severe test, namely a panel 15 ft. 8 ins. x 16 ft. 8 ins. thickness of floor slab 5¼ ins., under load of 100 tons, gave a deflection of the floor slab in the center of 5-32 of an inch, deflection of the beams a scant 1-16-in. If my critic can show an equally good test on the construction which he claims is properly designed, it will interest the writer and probably some of your readers.



A 100-TON TEST LOAD ON A REINFORCED CONCRETE FLOOR PANEL OF THE NORTHWEST KNITTING WORKS BUILDING, MINNEAPOLIS, MINN.; SIZE OF PANEL: 16 FT. 8 INS. X 15 FT. 8 INS. DEFLECTION OF BEAMS, 1-16 IN.

I hand you herewith photograph showing the test load. As regards the final criticism the only profitable place that the writer knows of in which to argue a nice distinction of patent law is in the courts and the writer is always ready for a profitable argument of that kind wherever there is an opportunity or suitable occasion to take it up.

As regards the general question of shear, the connection of beams with columns in the majority of designs that the writer has investigated in reinforced concrete building work are somewhat deficient in strength, while the form of reinforcement used in this provides several times the sectional area of steel necessary to take care of this shear and utilizes the area in providing for the bending moment.

I think your critic will appreciate the force of the illustration given in the case of the roof between assumed or half-baked theory and matter of fact as indicated by substantial test.

Respectfully yours,

C. A. P. Turner.

816 Phoenix Building, Minneapolis, Minn., June 19, 1905.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AT ASHEVILLE, N. C.

An innovation of note was made by the American Institute of Electrical Engineers in holding its 22d annual convention south of the Potomac River—at Asheville in the North Carolina mountains. The convention, which occupied the five days June 19 to 23, 1905, evolved into an element of "our great nation reconciliation," as Mayor Barnard phrased it in his welcoming address. A very large Southern representation attended the convention, and the local members did their utmost to charm the Northerners with the life and manners of the South. Excellent weather and the beauty of the mountain country around Asheville forwarded these efforts. From the technical standpoint also the convention was highly successful, since the program of papers contained an exceptional amount of valuable matter. The meeting stands as probably the best held for several years past.

As this society customarily transacts its routine of annual business at a meeting held some time before the annual convention, the latter is left almost wholly for professional proceedings and such matters as excursions, banquet, etc. At the present convention, therefore, an arrangement was used which has proved itself convenient in the past; the mornings were devoted to professional sessions, while the afternoons and evenings were occupied by sightseeing trips and other entertainments. The latter comprised a banquet at the Battery Park Hotel (where the convention headquarters were also located), a ball at the same place, a smoker at the Albemarle Club, an organ recital, a trolley trip, and three excursions, respectively a drive through the Biltmore estate, a visit to the Weaver Power Company's water-power electric plant on the French Broad River several miles below Asheville, and an all-day excursion by rail to Lake Toxaway, some sixty miles southwest of the city. While all these entertainments were well planned and successful, the Toxaway trip and the drive through Biltmore were of the most general attraction. The former gave an excellent panorama of the wooded mountain country which forms the charm of the region. The drive through the Biltmore estate, a ten-mile study in greens of every shade and arrangement, was sketched in these columns two years ago, at the time of the Asheville convention of the American Society of Civil Engineers. An especially notable feature of the estate, aside from the aesthetic results produced by its artistic development, is that it is the place where the first scientific forestry in that part of the country was done. This work, begun a dozen years ago, is a permanent element in the maintenance of the estate; a large part of the area indeed is expressly set aside as a forest reserve, while the remainder, of which a large proportion is wooded, is treated throughout with careful regard to the interests of the standing timber.

There is the more specific interest in this matter of forest protection at the present moment, because the subject came up in the course of the technical program of the convention. A paper dealing with the theme, "The Forestry Problem in connection with Water Powers in the Southern Appalachians," was read by Mr. Charles E. Waddell (Biltmore, N. C.), who made a strong plea for public action in favor of the protection of forests in the southern mountain regions. Later during the convention, a resolution was presented and passed, voicing the sentiment that forest protection is urgently needed, both as a safeguard against floods and in the interests of water-power, and calling upon all competent public authorities to work toward such protection. This resolution does not confine itself to the Southern Appalachians, but is of general statement. However, conditions in the southern mountains make the question of forest preservation peculiarly important for that region. The country is of steep slope; the streams which rise there are in general short and draw their principal supply from the mountain region, so that the equalization of run off in the mountains is vital to the regulation of these streams. Though still largely wooded, the region has been denuded to a sufficient extent to seriously increase the normal irregularity of the rivers, raising the flood heights and discharges, and enormously increasing the soil erosion and stream transportation. The soil over the entire district is of such a nature that it erodes with remarkable rapidity, with the result that not only is the agricultural value of the soil destroyed but also the rivers are surcharged with silt and conditions thus created which greatly increase the destructive effects of floods. For a number of years there has been before Congress a project for the creation of an Appalachian Forest Reserve, embracing the mountain region from West Virginia down to Georgia. But this project has made very little headway, and the present sentiment, as expressed in the resolutions above mentioned, is that united action of the general government and the State governments for control of lumbering, supervision of forests, and protection against fires, must be secured.

The professional sessions of the convention were prefaced, after a welcome by Mayor A. S. Barnard, of Asheville, by the Presidential Address, delivered by President John S. Lieb (New York, N. Y.) This was an analytical study of the field and functions of national engineering societies, embodying various suggestions for the development of the American Institute of Electrical Engineers. The address was by special resolution referred to the Board of Managers for consideration leading to concrete proposals for improving the efficiency of the society. It is reproduced in abstract elsewhere in this issue.

Professional Proceedings.

Much interest centered in that part of the program which dealt with high-voltage electric transmission. Two important papers bearing directly on this subject were read, while three others had close relation on the same subject.

DISTURBANCES IN HIGH-POTENTIAL SYSTEMS.

Two striking and valuable papers, dealing with electrical disturbances in high-tension transmission or distribution systems, opened the technical work of the convention. Mr. Charles P. Steinmetz (Schenectady, N. Y.), in a paper entitled "High-Power Surges in Electric Distribution Systems of Great Magnitude," described a remarkable surge which occurred two years ago in the high-tension distribution network (underground) of the Manhattan Railway Co. of New York City, and which had such power and did such extensive damage as to require the entire station to be shut down temporarily. He followed the description with a mathematical study of the phenomenon, basing on the assumption that it was due directly to a short-circuit arc in a manhole near the power-station, which arc was ruptured by the excessive current flowing through it, then re-established itself as the potential of the cable returned, then again ruptured itself, and so on periodically. The mathematical development shows that this succession of momentary jets of current, whose frequency may be calculated from the conditions of the cable-system, sets up a series of wave-trains in the system which result in very excessive voltage-stress in the cable and also very great surges of current; the former break down the insulation at various points, and may discharge at exposed parts of the circuit, while the surges of current may burn out portions of the wiring and may damage apparatus both by voltage-concentration on the outer turns of windings and by bending and wrenching apart armature coils, bus bars, and the like. One feature of the paper is its showing that a third frequency, in addition to those already recognized (1. the generator frequency, and 2. the frequency of the oscillation of the whole wiring system), needs to be considered in discussions of abnormal phenomena in the class of circuits in question. This third frequency is the frequency of rupture and re-establishment of an arc which may form in air at some point of the system. Another feature is the succinct account of the great surge which is discussed, in combination with a clear non-mathematical statement of its cause (on the au[illegible] theory). This portion of the paper we hope [illegible] print in another issue of Engineering Ne[illegible]

The second paper above referred to was [illegible] Experimental Study of The Rise of Poten[illegible] Commercial Transmission Lines due to Stat[illegible] turbances caused by Switching, Grounding [illegible] by Mr. Percy H. Thomas (Pittsburg, Pa.) [illegible] experiments described were made on the [illegible] voltage lines of the Telluride Power Co., the [illegible] souri River Power Co., and the Utah Li[illegible] Power Co., all located in the easterly Rocky M[illegible] tain region. They included observations [illegible] rise of potential at various points of a line [illegible] the line was thrown into or out of circu[illegible] numerous different combinations of transm[illegible] lines and machines (transformers and gener[illegible] The potential was in all cases measured by s[illegible] gaps, which were so adjusted, by successive [illegible] in each experiment, that each gap was ju[illegible] yond the sparking limit at its location, whil[illegible] any one gap would break down if closed sl[illegible]; thus a measure of the voltage at the various [illegible] was obtained without distortion of the el[illegible] conditions by actual discharge of the gaps. The transmission lines in question were 6 to 12[illegible] long. Cases of potential rise (above norma[illegible] up to nearly 100% normal pressure were noted. In one case where resonance was produced [illegible] tionally, by charging an open line from a trans-former and connecting a dead transformer on the side opposite to the line, maximum potential up to three times normal were observed. The paper as a whole contains very many test results and comments; but the amount and diversity of the material make it impossible to summarize it here.

The discussion of these two papers gave strong evidence that their common theme is highly important to the electrical art of to-day. Mr. Thomas, in spite of the learned explanation which Mr. Steinmetz gave of the Manhattan surge, offered a radically different explanation of the same occurrence. He holds, primarily, that the conception of a very large arc which ruptures and re-establishes itself in rapid periodicity is exceedingly difficult. He therefore seeks an explanation in electric resonance (Mr. Steinmetz' "second frequency"): Suppose one of the feeders of a distributing system breaks down near its outer end; the corresponding transformer in the substation will then have an unbalanced inductance in excess of that of the other two (star-connected) transformers, and this unbalanced inductance will be opposed to the capacity of the cable system. The current supplied by the generators will resonate over this circuit, producing thereby great voltage rise at different points and a very great current flow; all the phenomena observed in the Manhattan case may be explained from such an action. A somewhat similar case in Europe, investigated mathematically by Kapp and found to be pure resonance, was cited by Mr. Thomas in support of his view. Mr. Steinmetz, however, stated that he had undoubted evidence of the possibility that periodic arcs as described may occur. He finds their first recognition in Wurts' work on non-arcing lightning arresters, though the observation is there stated too generally and not with sufficient clearness. The Wehnelt interrupter is also an instance of an arc rupturing by excess of current flow and then re-establishing itself. Relatively unlimited current flow, and a voltage high enough to spark across the gap, are essential conditions of the periodic arc. The latter is utilized commercially, for the purpose of producing high-potential oscillations. On the other hand, the phenomena described in Mr. Thomas' paper are held by Mr. Steinmetz to be pure oscillatory phenomena (due to the second frequency). He made similar tests on a line at Kalamazoo, Mich., some years ago, observing the potentials by oscillograph. Rises of 25,000 to 30,000 volts were frequently observed in switching in this circuit, with individual peaks as high as 180,000 volts. Air-break switches gave the most serious concentrations of potential. Mr. H. W. Fisher (Pittsburg, Pa.) stated that he had observed the effect of arcs in producing great potential rise some twelve years ago; but he also found that an open arc was not essential, since he got similar rise with other

such as arcs in oil. Using very short lengths of cable (20 ft.) he obtained potentials six to eight times the normal voltage. In the same connection Mr. Steinmetz stated that while he had formerly believed in fuses for large systems, he has found during the past year found, in repeated tests, that fuses blowing in branch lines of high-potential systems did not produce any rise of potential, as observed by oscillograph. This is counter to the general idea that fuses open circuits abruptly and therefore must cause pressure rises.

Mr. H. G. Stott (New York, N. Y.) gave further information about the Manhattan surge described by Mr. Steinmetz. The accident put one generator out of service for about two weeks, and destroyed the insulation of 13 cables in several places. In occurrences of this kind it is noted that the static ground detectors show a ground on one phase some time before a feeder short-circuits (5 to 25 mins.) If the grounded cable could be isolated before the ground has burned the insulation, the short-circuit would be avoided; but to test all the feeders requires about ¾-hr., so that in many cases the faulty feeder could not be located in time to prevent the short-circuit. It is therefore necessary to ground the neutral point of the generators (11,000 volts, star). The execution of this plan has been delayed because the Manhattan and Subway power houses have been operated in multiple, but the grounded system will be put into use on the Interborough (elevated and subway) distribution network within a very short time. The speaker also devised the scheme of putting a resistance in the ground connection, to avoid carrying excessive currents on the lead sheath of the cables; but it turned out that this had been previously invented and patented by Mr. W. F. Potter. It is recognized that the prevention of recurrence of the accident depends largely on the avoidance of open-air arcs. In switching this is secured by using oil switches, but danger remains in the cable system. The weak points in the latter are the manholes, as no trouble occurs in the ducts. To guard against flaring arcs in the manholes, the cables are wrapped with asbestos and steel tape, and have been covered with full iron sheathing, which can carry the current of a ground until the circuit-breaker opens. A reassuring statement regarding the reliability of large systems was made by Mr. J. W. Lieb (New York, N. Y.), namely, that on the New York Edison system fully ten times as many failures occur through mistakes on the part of operators as through any other cause. The disturbances from causes such as surging are therefore only a minor part of the question of regular operation. He also drew attention to the difficulty of starting up a large system when it has been completely shut down, a difficulty which is small on railway systems but very great on lighting systems. The latter class of systems, moreover, can not be subjected to experiments, as is possible with traction or power systems. In order to get some idea of the effect of starting up a long feeder line, in the New York system, it was necessary to connect across to the Brooklyn system and use one of their feeders running to a large converter station at Coney Island, about fifteen miles from the New York station. The relation of the disturbance question to long-distance power transmission was touched by Mr. P. N. Nunn (Niagara Falls, N. Y.), who was instrumental in making possible the tests described by Mr. Thomas. The art of long-distance transmission, he stated, is distinctly behind most other branches of the electrical art. Just as years ago it required a machine-shop to run a few motors, so to-day transmission work is subject to great uncertainties and unsatisfactory operation. Both theoretical knowledge and practical control of disturbing factors is largely lacking. Work such as contained in the two papers in question will, however, reform this condition in time. The main trouble in transmission systems is not caused by lightning, but is due to operative disturbances. We have to-day not the means, for instance, of cutting out a section of transmission line without producing a disturbance involving the risk of a shut-down. A concrete case of a similar disturbance was reported by Mr. F. A. C. Perrine (New York, N. Y.) In a California transmission plant an oil switch burst on opening. The electric disturbance was so severe that induced currents appeared throughout the steelwork of the station, causing flashes all over the framework. In some experiments in Hartford, Conn., by Mr. Steinmetz, the opening of a switch on a dead line produced sufficient disturbance on neighboring lines in service to open their circuit-breakers.

AN ELECTROSTATIC VOLTMETER FOR HIGH VOLTAGE.

A new device for measuring very high potentials was described by Mr. S. M. Kintner (Pittsburgh, Pa.) in a paper entitled "Methods of Measurement of High Electrical Pressures." The device is a simple development of the quadrant electrometer, with two special features which largely determine its effectiveness: 1. The moving element is hollow, and the whole instrument is filled with oil, which firstly gives great insulation strength, less distance between elements and consequently high torque, and secondly floats the moving element and also damps its motion. 2. The stationary elements, which surround the moving element, are so shaped as to give a scale of approximately uniform division over the desired working range. Voltmeters of this form have been built up to 100,000 volts, but the author believes they can readily be made for 200,000 volts and over.

The paper not only describes this instrument, but also gives an analysis of the utility of the various available means for measuring high pressures: the transformer ratio method, the fractional voltage method by auxiliary coil or by taps from the transformer, the voltmeter—resistance method, condenser methods (voltage or current), and the spark-gap. The latter is given most detailed study, because it is the established standard for measuring high voltages. It has many peculiarities, many sources of error, and many disadvantages which make it unavailable for many classes of work. On the other hand, it measures the maximum pressure (or some other function of the wave-form), while a static voltmeter and most of the other methods measure effective pressure; the former is taken as the measure of insulation stress, and is therefore the desired value. The ratio between effective and maximum is constant only when the wave-form of the voltage alternations is constant. However, many pressures which require measurement are not of the standard size-form, nor of any constant or determinable form, so that, as Mr. C. P. Steinmetz pointed out in discussion, the electrostatic instrument may give valueless indications even when the instrument is not in error. It is necessary, therefore, that such an instrument be calibrated by a standard spark-gap in every case where an important measurement is to be made, the spark-gap being used under the exact conditions under which the electrostatic instrument is to give its indications. With this precaution the electrostatic voltmeter will doubtless prove a most valuable measuring device.

On the subject of spark-gaps it may be noted that some of the eccentricities of this device are excellently shown in the paper by curves of sparking-distance obtained under different conditions. They give a suggestion of the work remaining to be done before the spark-gap can be considered a generally-available measuring instrument. The author concludes that, for calibrating the electrostatic instrument, the shielded spark-gap is the best, i. e., a gap which has metal shields normal to the gap a fraction of an inch back of the spark-points. Such a gap gives a jumping-distance curve quite different from that of the "standard" unshielded sharp-pointed gap. Mr. Steinmetz, whose early work on spark distances is fundamental, objected that the shielded gap should not be used for measurement, because the shields wholly alter the stress distribution within the gap and therefore change the relations between voltage and spark-distance. Mr. H. G. Stott (New York, N. Y.) and Prof. Samuel Sheldon (Brooklyn, N. Y.) reported cases where the spark-gap had proved unsuitable. Prof. Sheldon, in testing Holtz (electrostatic) machines found that both the spark-gap and the method of condensers in series with a voltmeter proved unreliable. He succeeded well, however, with a form of electric tourniquet or Barker's Mill, in which the discharge of a succession of sparks from tangential points on a light vane caused the vane to rotate at a speed depending on the voltage. Mr. Stott found that the gap discharging as soon as set destroyed itself by burning the needle-points, so that another means of measuring had to be used. The use of an electrostatic voltmeter calibrated by transformer ratio before and after each test gave complete satisfaction. Some remarks on the double curvature of spark-gap curves given in the paper led Mr. C. P. Steinmetz to state that he has been able, by mathematical reasoning, on the simple assumption that air breaks down at a fixed potential gradient, to develop a formula for spark distance, which fully agrees with the curve shown by Mr. Kintner.

The other two papers concerned mainly with high-tension work were "Data Relating to Electric Conductors and Cables," by Mr. H. W. Fisher (Pittsburg, Pa)., and "The Constant-Current Mercury Arc Rectifier," by Mr. C. P. Steinmetz (Schenectady, N. Y.). The first of these gave a great deal of information, mainly the results of tests, on resistance and impedance of cables, heat-conducting power of insulating compounds, heating of cables with various currents, and in various positions in a duct-system, variation of insulation resistance and capacity with temperature, and breaking-down pressure for various thicknesses of insulation (gutta-percha and paper). A noteworthy feature of the latter item is that the table includes cable for 21,000 to 23,000 volts working pressure, 46,000 volts factory test and 33,500 volts installed test; the insulation thickness in this case is 17-32 to 19-32-in. paper. The table is said to give a large margin of safety. It indicates that manufacturers are now prepared to furnish cable for working pressures up to about 25,000 volts and that high-voltage cable transmission is coming appreciably nearer.

In commenting on the paper, Mr. H. G. Stott (New York, N. Y) remarked that since the cable makers have now progressed to the point of giving out information about their work, we may next expect the telephone companies to come out with contributions about their art.

The paper of Mr. Steinmetz on the constant-current mercury arc rectifier gave, 1. Test characteristics, including oscillograph curves, of several rectifiers in use at Schenectady to supply constant current for series arc lighting circuits, and, 2, a mathematical study of the operation of the rectifier, based on the fact that current flows to the cathode from any anode having positive potential above zero. The computed curves agree accurately with those observed by oscillograph. One rectifier has been running on a circuit of mercury-vapor lamps, while another has been supplying magnetite lamps. He reported that these rectifiers have been found to stand the highest available test voltages, and without deterioration or lowered efficiency, so that a great range of use is open to them. These devices may bring the direct-current series arc into general favor again, as its better efficiency over the alternating arc gives it a material advantage as soon as the difficulty of current conversion is overcome. The rectifying effect of mercury arcs is not new; Mr. F. A. C. Perrine (New York, N. Y.) put the discovery of this effect as far back as 1875. In defense of his classification of the mercury-vapor rectifier as an arc device, which classification was questioned, Mr. Steinmetz asserted that the phenomena of its action are identical with those of any other arc. In the mercury arc, however, the rectifying temperature range is greatest, which makes it the most useful for this work. In the carbon arc the rectifying effect disappears at a temperature just below the temperature of the carbons in a practically workable arc.

We postpone report of the remaining proceedings of the convention to our next issue.

WATERPROOFING THE PENNSYLVANIA R. R. TUNNELS AT NEW YORK.

The problem of waterproofing concrete lined tunnels is of such importance that the following revised specifications for the Pennsylvania R. R. tunnel work in New York City will be of interest.

(297) The space less thickness of waterproofing between the sides of the excavation and the neat lines shall be filled with concrete behind suitable forms. After the forms are removed the surface of the concrete shall be given a ½-in. coat of mortar containing equal parts by volume of Portland Cement and sand and troweled smooth. After the mortar has set and dried out, it shall be covered with alternate layers of coal-tar pitch and felt, seven layers of pitch and six of felt. The felt shall be "Hydrex" Felt, manufactured by F. W. Bird & Son, of East Walpole, Mass., or felt equally satisfactory to the engineer. The pitch shall be straight run coat-tar pitch which will soften at 60° Fahrenheit, being a grade in which distillate oils, distilled therefrom, shall have a specific gravity of 1.105. The pitch shall be mopped on the surface of the concrete to a uniform thickness of not less than 1-16 in. Immediately on this coat of pitch, and while it is still melted, there shall be laid a covering of felt, the sheets to lap not less than 12 ins. on both transverse and longitudinal joints, and to be made to adhere firmly to the pitch covered surface of the concrete everywhere. This felt layer shall be mopped with pitch as above specified, another layer of felt then added, as above specified, another layer of felt then added and mopped with pitch, and the process continued to the full number of layers required. This waterproofing shall extend from the level of the bottom of the electric ducts to a point about 22° 30′ above the spring line of the roof arch. After the waterproofing has been placed the remainder of the concrete with the electric ducts, etc., shall be placed.

(298) The roofs of tunnels shall be covered with two tripple layers of felt and seven layers of pitch each of the quality specified in the preceding paragraph, except that the layer of pitch laid directly on the brick, the layer between the third and fourth layers of felt and the outer layer shall soften at about 32° F., and melt at about 60° F., so that it can be spread without heating. A layer of this shall be spread on the brick and covered with a layer made up of three thicknesses of felt interlaid with pitch of the quality described in the preceding paragraph. On this triple layer shall be spread another layer of soft pitch followed by another triple layer of felt and the whole covered with a third layer of soft pitch, the whole constituting seven layers of pitch and six thicknesses of felt. On the longitudinal joints the triple layers shall lap at least 2 ins. of triple thickness, making 10 ins. including the single and double thicknesses, and on the cross joints the lap shall be 6 ins. greater. The wateproofing courses above described shall be covered with one course of brick laid flat in a ½ in. bed of mortar containing equal parts by volume of cement and sand and the joints completely filled with mortar of the same composition. The junction between the waterproofing in the roof and sides shall be formed so as to make a continuous waterproofing. The right is reserved to the engineer to substitute for the waterproofing above described any other which in his judgment will be more satisfactory or advantageous to the company, and he will fix the unit prices therefor. In such unit prices the Contractor shall be entitled to the allowance for contingencies and profit as exist in his price for the waterproofing above specified.

THE ENGINEER VICTIMS OF THE MENTOR WRECK.

The recent disastrous wreck of a Lake Shore & Michigan Southern Ry. train at Mentor, O., was remarkable for the number of persons identified with important engineering and industrial enterprises who met their death in it. Among those who were killed in the accident were Charles H. Wellman, General Manager of the Wellman-Seaver-Morgan Co., of Cleveland, O.; Thomas R. Morgan, Second Vice-President of the Wellman-Seaver-Morgan Co.; Archibald P. Head, of London, England, one of the most widely known of English metallurgical engineers; A. L. Rogers, of New York City, Assistant to the President of the Platt Iron Works, of Dayton, O.; Harry H. Wright, General Manager of the Featherstone Foundry & Machine Co., and Vice-President of the Hewitt Mfg. Co. of Chicago; E. E. Naugle, of the Naugle Railway Tie Co., of Chicago; Mr. H. C. Mechling, Eastern Manager of the Wheeling Corrugating Co.; J. H. Gibson, Secretary American Foundry & Machine Co., of Chicago., and John R. Bennett, of New York City, widely known as a patent attorney.

Mr. Archibald P. Head was a member of the Iron and Steel Institute, of the Institution of Civil Engineers and of the Institution of Mechanical Engineers of Great Britain. He was an expert of international reputation on iron and steel metallurgical practice. A paper contributed by him to the Iron and Steel Institute on American rolling mill practice a few years ago did much to attract the attention of foreigners to the work done in this country. He was one of the directors of the Otis Steel Co., of Cleveland, representing the English interests in that company.

Mr. Charles H. Wellman was born June 12 1865, at Nashua, N. H., his father being Superintendent of the Nashua Iron Co. In October, 1881, Mr. Wellman secured a position at the works of the Morgan Engineering Co., Alliance, O., where he served his time as machinist and draftsman. In 1885 he became Chief Draftsman at the Otis Steel Works, Cleveland, O., and soon thereafter was placed in charge of the Open Hearth department. In 1890 he became Superintendent of the Wellman Steel Co., at Thurlow, Pa., leaving there in 1895 to become Open Hearth Superintendent of the Illinois Steel Co. at South Chicago. In 1896, with Mr. S. T. Wellman, who is now President of the Wellman-Seaver-Morgan Co., and with Mr. John W. Seaver, now Chairman of that company, he organized the Wellman-Seaver Engineering Co., becoming Engineer and General Manager. At the time of his death he was General Manager of the Wellman-Seaver-Morgan Company. Mr. Wellman was a member of the American Society of Mechanical Engineers.

Mr. Thomas R. Morgan was born in 1859 in South Wales and came to this country at the age of six. His father organized the Pittsburg Steam Hammer Works, and later removed to Alliance, O., engaging in the business which afterward became the Morgan Engineering Co. Mr. Morgan's practical experience began in his father's works in Pittsburg, and after finishing his studies in Mt. Union College, he entered the works at Alliance, becoming Superintendent of the works at the age of 16, General Manager at 21, and at 25 was Secretary and General Manager of the company. In 1897, on the death of his father, he disposed of his interests and severed his connection with the company, and later engaged with the Wellman-Seaver Engineering Co. In 1902 in recognition of his services and ability, the name of the company was changed to The Wellman-Seaver-Morgan Engineering Co., of which he was at that time Secretary and Works Manager. On consolidation with the Webster, Camp & Lane Co. of Akron, O., the company name was changed to the present title, The Wellman-Seaver-Morgan Co., Mr. Morgan being Second Vice-President and Works Manager at the time of his death. Mr. Morgan had been a member of the American Society of Mechanical Engineers since 1884.

Mr. A. L. Rogers was assistant to the President of the Platt Iron Works of Dayton, O. He was formerly connected with the Stirling Boiler Co. and was well known throughout the iron and steel trade of the country. He was about 40 years old and resided at New Rochelle, N. Y. He was a member of the Engineers' Club of New York City.

Mr. John R. Bennett was one of the most prominent patent attorneys in the United States, and had acted as counsel for a large number of prominent manufacturing companies in connection with patent litigation.

NOTES FROM THE ENGINEERING COLLEGES.

WASHINGTON UNIVERSITY.—The dedication of the new building of Washington University occurred on June 15. On that occasion five of the engineering alumni of the University were given honorary degrees as follows: M. L. Holman (class of 1874), Consulting Engineer, St. Louis, Mo.; George H. Pegram (class of 1877), Chief Engineer, Interborough Rapid Transit Co. of New York City; Charles W. Bryan (class of 1884), Contracting Manager of American Bridge Co., of New York City, and Richard McCulloch (class of 1891), Assistant General Manager United Railways of St. Louis. These four alumni were granted the degree of Master of Arts; and William G. Raymond (class of 1884), Dean of the Department of Engineering of the University of Iowa, was granted the degree of Doctor of Laws.

Of the eleven granite buildings already built, three are exclusively for the use of the School of Engineering and Architecture, while the engineering students also have use of all the others for their general work and purposes. The three buildings mentioned were given by Mr. Samuel Cupples, of St. Louis, and they cost, with their furnishings and equipment, more than $300,000.

The Civil Engineering Department occupies the second floor of Cupples Building No. 1. It has three class-rooms about 25×36 ft.; two instructor's offices, about 10×18 ft.; two professors' offices about 13 ft. square; an instrument room with a very complete surveying instrument cabinet, about 16×18 ft.; a department library room about 18×50 ft.; a blue printing room and a student study each about 18 ft. square; a drafting room thoroughly lighted from the north about 18×75 ft., and a civil engineering museum about 18×75 ft. The latter room is filled with photographs and drawings illustrating railway, highway, irrigation, harbor, river, canal, water supply, sewerage, hydraulic and structural engineering works, with specimens illustrating properties and use of engineering materials, sectional models of water and gas meters, rail sections and joints, a collection of 140 specimens of Portland cement materials and samples, taken at different stages in its manufacture, from the different manufacturing regions of the United States, models of breakwaters, jetties, etc., etc.

The Mechanical Engineering Department has about the same space devoted to its needs on the first floor of Cupples Building No. 2; and the Electrical Engineering Department occupies the second floor of this same building. The Architectural Building, organized three years ago, occupies a space about equal to each of the three departments already mentioned with equipment already extensive, and this year for the third time received several of the prizes at the annual competition of the Society of Beaux Arts Architects in New York City. The Chemical Engineering Department occupies quarters in the separate building devoted entirely to chemistry, across the quadrangle from Cupples building No. 1.

The engineering laboratories occupy together a one-story building 60×200 ft. in size. In the eastern end is a shop fitted with lathes, drills, planers, milling machines, etc., for making repairs and for manufacturing special equipment.

The Mechanical Engineering laboratory equipment consists of a tandem-compound Corliss engine, two smaller steam engines, a gasoline and gas engine and a gas producer and condensers, pumps, dynamometers and other special equipment. The electrical laboratory equipment occupies the next 40 × 60 ft. with a considerable number of motors, generators, converters, transformers and other equipment. The westernmost 40×60 feet is occupied by the Civil Engineering laboratory equipment consisting of three Riehlé Universal testing machines of 200,000, 100,000 and 20,000 lbs. capacity, a 100,000-lb. beam machine, a 1,000,000-lb. compression (column) machine, a 60,000 inch-pound torsion machine, an abrasion machine, a paving brick rattler, several cement testing machines and all the accompanying apparatus and appliances to make complete the equipment for testing materials.

PRIZES FOR ESSAYS ON LEAD POISONING.

Twelve prizes for essays on means for combatting lead poisoning have been offered by the Internationales Arbeitsamt, of Basel, Switzerland, according to statements made by Mr. Wm. F. Wright, U. S. Consul-General at Munich, Germany. The particulars, as contributed by Consul Wright to Advance Consular Reports, under date of April 15, 1905, are as follows:

(1) A prize of 5,000 marks ($1,190) for the best essay upon the most practical method of eliminating the danger of lead poisoning during the process of handling lead ores.

(2) A prize of 10,000 marks ($2,380) for the best essay upon the elimination of the danger of lead poisoning in lead-smelting works.

(3) Two prizes, one of 2,500 marks ($595) and a second of 1,500 marks ($357), for the best essays upon the elimination of the danger of poisoning in chemical and electrical works where lead is in use.

(4) Four prizes, one of 1,500 marks ($357), a second of 1,000 marks ($238), and two of 750 marks ($178.50) each, for the best essays upon the most practical method

avoiding lead poisoning in trades such as painting, enameling, etc.

(5) Four prizes, one of 1,500 marks ($357), a second of 1,000 marks ($238), and two of 750 marks ($178.50) each, for the best essays upon the elimination of the danger of lead poisoning in factories where large quantities of lead are used, as, for instance, in type foundries, printing establishments, etc.

The essays must contain a systematic description of the source of lead poisoning, in which the mode of production is described and the dangers existing in each stage of the process, in transportation, etc., are mentioned. Other causes of lead poisoning are also to be given, as, for example, working too long at a certain process, uncleanliness, insufficient knowledge on the part of the workmen, bad or insufficient food, irrational mode of living, and unhealthy apartments.

The proposals made must give the possibility of elimination of the danger in such a manner that no objection can be made on technical, hygienic or economic grounds. The dangers are to be given, so far as possible, in classes, in order to make it clear at what stage of the process or under what conditions there is greatest and least danger.

In proposals for new apparatus or alterations in process, the cost and saving involved in such proposals must be given. For instance, in a proposal for substituting a mechanical process for hand work, the cost of the machines, loss by depreciation and interest, and, on the other hand, the wages and other expenses saved must be mentioned. The advantages gained by such methods, as, for instance, the avoidance of frequent changes in the staff, the training of a good staff, and increase in ability must also be given.

It is preferable that the essays contain proposals for improving the existing laws upon this subject in all States, and the alterations in legislation which would be necessary to carry out the proposals. They could also contain copies of proposed instructions to be affixed in factories for the guidance of the workmen.

The present laws upon this question are contained in the volume Gesundheitsgefaehrliche Industrien, issued by G. Fischer, Jena, 1903, and in the Bulletin des Internationalen Arbeitsamtes, 1901-1904. These books can be found in the following libraries in America: Library of the University of Chicago; City of Denver Public Library; Library of the Institut Medico Nacional, City of Mexico; Institute of Mining and Metallurgy, New York, and Library of Columbia University, same city; Omaha Public Library; Pueblo (Colo.) City Public Library; Library of the Washington University, St. Louis; City Library, Salt Lake City.

All the proposals made in the essays must be clearly summarized at the end thereof.

Papers may be written in English, French or German. Printed books will not be admitted. The completed manuscript must simply bear a title on the cover. The name of the author is to be inclosed in a sealed envelope which bears the title of the essay. The essays must reach the Internationales Arbeitsamt in Basel by Dec. 31, 1905. The Internationales Arbeitsamt will have the right to publish the prize essays, although the author retains the right of literary ownership. Articles not published will be returned to the authors. Should the 27,000 marks ($6,426) not all be used, the remainder may be devoted to any cause in the interest of the health of workmen. The names of the judges will be published at a later date.

All communications must be addressed to "Das Internationales Arbeitsamt, Basel, Switzerland," and should be sent by registered mail.

THE RECOVERY OF A DIAMOND-CROWN FROM A DEEP BORE-HOLE.*

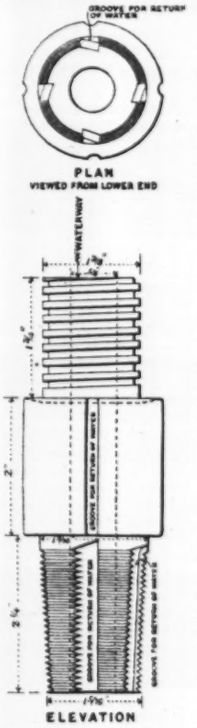
By Cuthbert Baring Horwood, Assoc. M. Inst. C. E.

The following is a description of work which came under the author's notice during the latter part of the year 1903.

With the object of exploring for the Van Ryn Reef, boring-operations were commenced in 1902, on a farm on the far East Rand, about 33 miles from Johannesburg. When work had proceeded for more than a year, and the bore-hole had reached a depth of 3,233 ft., the bit became jammed, and the rods were consequently withdrawn. When the last rod had been removed, the core-barrel, which was 40 ft. in length, was drawn up. On its arrival at the surface, it was found that the core-barrel contained no core, and that the shell and diamond-crown were missing.

The shell is a piece of steel tubing, about 4 ins. in length, containing the spring which holds the core in position in the barrel, and it forms the connecting-piece between the core-barrel and the bit or crown. The thread at the end of the core-barrel which screws into the shell, had broken off flush with the top of the shell. The core, with the exception of about ⅛ in. at the bottom end, was recovered without difficulty, and the shell was recovered by means of a tap, cut short in order to ensure its not being too long for the threaded tapered portion to grip the shell. When the shell was brought up, it was found that the crown had broken off from it, flush with the end of the shell, leaving its threaded portion within the shell.

In order to recover the crown, a special tap was made in Johannesburg. This tool was 6 ins. in length, of which 1¾ ins. was threaded to screw into the end of the bottom rod; the next 2 ins. consisted of a shoulder, 2 1-64 ins. in outside diameter, to guide the tool, and contained four longitudinal grooves or waterways to allow the water to pass up outside round the edge of the bore-hole; and the remaining 2¼ ins. consisted of a threaded tap, tapered from 1 9-16 ins. to 1 5-16 ins. in diameter. The tool was not solid, being ⅝-in. in inside diameter. It was made of steel, the end of the taper being softened to permit of diamonds being set in it. Four small diamonds (about 1½-carat in all) were set in the end, in order to cut, within the crown, through and beyond the rock in which it was presumably imbedded. By the use of this tool the crown was speedily recovered. All the diamonds were found to be intact; there were eight diamonds on the face of the crown, four inside and four outside, and also four inferior diamonds round the outside of the bit, to keep the hole sufficiently large to insure easy working, and to prevent the bit from becoming jammed. The carbons, when recovered, weighed 17 53-64 carats, and were valued at more than £230, or £13 per carat; moreover, having been used, their quality had been tested, and reliance could therefore be placed upon them.



When the crown was recovered, it was found to have been very badly burned, and to be worn down to only ⅛ in. in depth, a new crown being ¾ in. in depth, neglecting the threaded portion. The bit having first broken off flush with the end of the shell, the two parts had been grinding against each other. As it was afterwards discovered that three rods had split at a depth of between 1,700 and 2,000 ft. from the surface, it was concluded that the pressure-water, which is forced down through the rods and returns through the clearance-space between the outside of the rods and the side of the bore-hole had escaped where the split occurred, and so had found a quicker and easier course to the surface. Thus no circulation of water had been taking place around the bit to keep it cool and to carry away the cuttings. The bit would thus quickly become jammed, and, probably weakened by overheating, would be unable to withstand the torsion to which it was subjected, and would therefore break. The fracture occurred in the lower quartzites of the Upper Witwatersrand Beds.

The drill was a Sullivan machine, warranted to bore to a depth of 4,000 ft.; the rods used were of steel, of English manufacture, in 10-ft. lengths, which at this depth were unscrewed in 50-ft. lengths for removal. The core-barrel was in two 20-ft. lengths.

The risk involved in the accident was that the hole might have to be abandoned entirely. This would have meant: (1) a year's work wasted; (2) probably 9 months' delay before the same depth could again be reached in another hole; (3) loss of the total amount spent up to that time (about £8,000); (4) loss of £230 worth of diamonds; (5) loss owing to depreciation of plant and machinery for one year; and other incidental losses.

The reef was eventually struck at 3,412 ft.

*A paper read before the Institution of Civil Engineers, Session 1904-5.

THE BOARD OF CONSULTING ENGINEERS of the Isthmian Canal Commission has been officially announced and ordered to meet in Washington on Sept. 1.

The full text of the President's order is as follows:

June 24, 1905.

It is hereby ordered that a board of consulting engineers, consisting of General George W. Davis, Alfred Noble, William Barclay Parsons, William H. Burr, General Henry L. Abbot, Francis P. Stearns, Joseph Ripley, Isham Randolph, Herman Schussler (Americans), and William Henry Hunter, nominated by the British Government; Herr Eugen Tincanza, by the German Government; M. Guerard, by the French Government; M. Quellennec, Consulting Engineer of the Suez Canal; and one to be designated by the Government of the Netherlands, shall convene in the City of Washington, at the rooms of the Isthmian Canal Commission, on the first day of September, 1905, for the purpose of considering the various plans proposed to and by the Isthmian Canal Commission for the construction of a canal across the Isthmus of Panama, between Cristobal and La Boca; and that the deliberations of the board of consulting engineers shall continue as long as they deem it necessary and wise before they make their report to the Commission.

The Isthmian Canal Commission is directed to have all the proposed plans in such detailed form, with maps, surveys and other documents sufficient to enable the consulting engineers to consider and decide the questions presented to them.

Should it be deemed necessary by the members of the consulting board, they may visit the isthmus before making their final report. If there is a difference of opinion between the members of the consulting board, minority reports are requested.

General George W. Davis is hereby designated as chairman of the board of consulting engineers.

Instructions in detail will be given in time to be presented to the board when it first convenes on the 1st of September.

The chairman is directed to communicate the contents of this order to the different members, with such other details as may be necessary.

Theodore Roosevelt.

THE PHILADELPHIA FILTRATION WORK and other improvements to the city water supply are to be investigated by a board of engineers and by the Audit Co. of New York. This is an outcome of Mayor Weaver's reform measures and of recent allegations regarding the character of the work on the McNichol contracts. It is reported that Mr. Wm. Barclay Parsons and Mr. H. de B. Parsons have been engaged as two of this committee of engineers. The issuance of warrants on June 20 for the arrest of Mr. John W. Hill, formerly Chief Engineer of the Bureau of Filtration, on the charge of forgery of contract records was duplicated on June 23. At the hearings subsequent to each warrant, testimony was given designed to prove unwarranted increases in estimates for excavation on pipe laying contracts. In one case correspondence was introduced to show that, acting on orders from the then Director of Public Works, the contract price for earth excavated from trenches more than 18 ft. deep had been allowed for earth taken from a trench in which rock was encountered (presumably below the earth), thus making necessary a supplementary contract for $40,000 to provide for the excess of cost over the appropriation. At these hearings the defendant was not allowed to testify. The principal witnesses were ex-employees under Mr. Hill. The lawyer for the defence declared, at the second hearing, that the proceedings were in the nature of persecution instead of prosecution. The defendant was held under bail for trial. Since his resignation, Mr. Hill has opened offices for private practice in the Fidelity Building, Philadelphia, where he is receiving according to the Philadelphia newspapers, many letters of sympathy from engineers and others.

THE GREATER PITTSBURG ACT, providing for the consolidation of Allegheny and Pittsburg on an affirmative vote of each city, has been declared unconstitutional by the Supreme Court of Pennsylvania. The ground of the decision is that the legislation was special. In the course of its opinion the court called attention to its recent repeated warning against special legislation. The act in question was approved on April 20, 1905.

AFTER YEARS OF LITIGATION between the Ephrata Water Co. and the Borough of Ephrata, Pa., over hydrant rental the parties agreed to act under an arbitration clause in their contract. Messrs. Kenneth Allen, of Atlantic City and Emil L. Nuebling, of Reading, were chosen by the city and W. C. Hawley, of Wilkinsburg, Pa., and Murray Forbes, of Greensburg, Pa., by the company. These four agreed upon Mr. Emil Kuichling, of Rochester, N. Y., as a fifth appraiser. The appraisers reported on June 16, 1905, that the borough owed the company $9,747 for hydrant rental and interest from Nov. 1, 1894, to May 1, 1905; and that the value of the water-works plant, and franchise, after allowances "for depreciation and inadaptability of the existing system," on May 1, 1905, was $47,200. The borough has 30 days from June 16 to accept or reject the works at the appraisal value. In the litigation preceding the appraisal the borough won three times in the Court of Common Pleas, but each decision was reversed by the Supreme Court. On a fourth trial the lower court decided against the borough.

A LOW DAM NEAR ITHACA, N. Y., was carried away, on June 21, by a flood caused by a heavy rainfall in the drainage area of Six Mile Creek. This dam was located about a mile below the curved masonry dam built on the same stream not long ago, which fact gave rise to a report that the new dam had failed, but it is reported that it was not injured. The dam that failed was 12 to 15 ft. high and furnished power to pump water to the city filtration plant and to the East Hill reservoir. The failure disabled this pumping station, but there is another station which supplies water from a new driven well plant. Five engines have been used to pump water through hose from the Cornell University campus system to the city mains. A large part of the City of Ithaca was flooded by the heavy rain within the city and the flow of the creek.

A GROUP OF PUBLIC BUILDINGS, of harmonious design, and located upon a large public square, is likely to be established at Cleveland, and the subject is in the hands of a special commission of representatives of the city, county and Federal governments. The square or mall would be in the form of a T, the head lying along the lake front and the stem running south to Superior St.; the stem would also continue slightly beyond the head to a new union railway station, with bridges connecting with a park or ground to be filled in on the north side of the railway tracks. On one end of the head of the T would be the City Hall, and on the other end would be the County Building. Along the stem would be the public library and the post office and Federal building. After the property has been acquired, such portions as are not needed for the public buildings will be sold, but under restriction as to the character of the buildings to be erected by the purchasers. The sites for the City Hall and County Court House have been purchased, and the post office is already under construction. The estimated cost of the entire improvement is $20,000,000.

THE ABOLITION OF GRADE CROSSINGS AT CLEVELand, O., is to be undertaken, and an ordinance has been passed providing for the abolition of sub crossings on the Cleveland & Pittsburg division of the Pennsylvania Lines. Plans and specifications have been approved by the city engineer and the chief engineer of the railway, and the city will pay half the cost of the work. The railway and streets will be elevated and depressed at different points owing to the topographical conditions. The work is to be completed in two years, and the estimated cost is $825,000.

PERSONALS.

Mr. Eduardo Charme has been appointed Minister of Industry and Public Works in the new Cabinet of Chili.

Mr. Joseph T. Lillich, Jun. Am. Soc. C. E., and Miss May Lucille Rudden, were married June 19, at St. Louis, Mo.

Mr. J. L. Campbell has been appointed Engineer of Maintenance of Way of the El Paso & Southwestern R. R.

Mr. Frank A. Freeland, a civil engineer of Athensean, Ia., and Miss Sadie White of Holyoke, Colo., were married recently.

Mr. Davis Turnbuil, a civil engineer of Pittsburg, Pa., and Miss June Clemens Detweiler were married June 8, in St. Mark's Church, New York City.

Mr. Charles Dunham, formerly Signal Engineer for the Illinois Central R. R., has been appointed to the same position for the Great Northern Ry.

Mr. J. W. Eber, assistant to the Engineer of Maintenance of Way of the New York Central & Hudson River R. R., has been appointed Engineer of Track.

Mr. John Findley Wallace, M. Am. Soc. C. E., according to dispatches from Washington, has tendered his resignation as Chief Engineer of the Isthmian Canal Commission.

Mr. E. D. Bolton, of New York, has been appointed Resident Engineer and Superintendent of Construction of the Municipal water filtration plant, which is to be built at Toledo, O.

Mr. Charles Francis Duc de Nevers, M. Am. Soc. C. E., of Boonton, N. J., and Miss Helene B. Turck, of Croghan, N. Y., were married at Zion Episcopal Church, New York City, on Sunday, June 4.

Mr. C. H. Marquess has resigned his position as Chief Draftsman at the U. S. Navy Yard, Charleston, S. C., to accept the position of Chief Engineer with Moise De Leon, general contractor, Atlanta, Ga.

Mr. William E. Gibbs, of Fanwood, N. J., has been appointed Professor of Physics in the Carnegie Technical Schools, Pittsburg, Pa. Professor Gibbs is a graduate of the Stevens Institute of Technology.

Mr. Charles S. Farnham has resigned as Assistant City Engineer of Hartford, Conn., to become an Instructor in the Sheffield Scientific School of Yale University, from which institution he was graduated in the class of 1902.

Mr. F. W. Allen, formerly a Division Engineer on the Erie R. R., and later Roadmaster of the Cascade Division of the Great Northern Ry., is now Assistant Superintendent of the newly created Minot Division of the latter railroad.

Mr. Rhoades Fisher, Jr., has been appointed a member of the engineering staff of the Juragua Mining Co., Fersneza, Cuba. Mr. Fisher has recently completed the surveys and designs for the water supply project of Camaguey, Cuba.

Mr. Bernard A. Etcherverry has been appointed Instructor in Irrigation Engineering at the University of California. For the past two years Mr. Etcherverry has been Associate Professor of Civil Engineering at the University of Nebraska.

Mr. Olin H. Landreth, M. Am. Soc. C. E., Consulting Engineer of the New York State Board of Health and Professor of Engineering at Union College, received the honorary degree of Doctor of Science at the recent commencement of that institution.

Mr. J. F. White, heretofore Engineer of Maintenance of Way of the Cincinnati, Hamilton & Dayton Ry., has been appointed Superintendent of the Northern and Southern Divisions, with headquarters at Dayton, O., succeeding Mr. R. H. Bowron, promoted.

Mr. John P. Denison has resigned his position as Western General Sales Agent of the New York Continental Jewell Filtration Co., and is now Western General Manager of the filter department of the Norwood Engineering Co., with headquarters in the Hartford Building, Chicago, Ill.

Mr. Walter K. Ganong has been promoted from the position of Instructor to that of Acting Professor in the Electrical Engineering Department at the University of Maine. The vacancy in that department has been filled by the appointment of Mr. Howard D. Carpenter, a graduate of Princeton University, class of 1895.

Mr. P. W. Ellis, of Toronto, Ont., and Lieut. Col. Clarke Raymond, Welland, Ont., have been appointed members of the Queen Victoria Niagara Falls Park Commission, to succeed Mr. A. W. Campbell, Deputy Commissioner of Public Works, and Mr. James Bampfield, resigned.

At the thirty-third annual commencement of Stevens Institute of Technology, June 21, the honorary degree of Doctor of Engineering was conferred upon Palmer Ricketts, M. Am. Soc. C. E., President of Rensselaer Polytechnic Institute; Col. Edwin A. Stevens, Consulting Naval Engineer, and Capt. David W. Taylor, Naval Constructor, U. S. Navy.

Mr. W. S. Kinnear, Assistant General Manager and Chief Engineer of the Michigan Central R. R., has been relieved from the duties of the last named position in order that he may be able to devote more time to the building of the railroad tunnel under the Detroit River. Mr. George H. Webb, at present Assistant Chief Engineer, will succeed Mr. Kinnear.

Mr. R. K. Rochester, hitherto Engineer of Maintenance of Way of the Vandalia R. R., has been appointed Principal Assistant Engineer, and Mr. E. L. Shaneberger, formerly Engineer of Maintenance of Way of the Peoria Division, has been appointed Engineer of Maintenance of Way, with headquarters at Logansport, Ind., to succeed Mr. Rochester. Mr. H. C. Johnson, heretofore Assistant Engineer at Logansport, succeeds Mr. Shaneberger.

Messrs. John Birkinbine, of Cynwyd; John F. Wentworth, of Kittaning, and Henry M. Brackenridge, of Pittsburg, have been appointed members of the State Water Supply Commission, by Governor Pennypacker, of Pennsylvania. The Commissioners, who will get a salary of $3,000 per year, will examine the water supply sources of the State, pass upon all charters for water companies, and recommend such legislation as they may deem necessary. The other members of the Commission are State Forestry Commissioner Conklin and State Health Commissioner Dixon.

Mr. F. J. Seery has been appointed Assistant Engineer of New York State Barge Canals and has been assigned to the Western Division at Medina, N. Y. Mr. Seery is a recent graduate of Tufts College, and previous to entering college had been engaged in engineering work with the City Engineer of Waterbury, Conn. He was a member of the Darien Exploration Survey under the U. S. Isthmian Canal Commission in 1900, and he had also been in the service of the U. S. Geological Survey and as Resident Engineer at Fulton, N. Y., under Mr. Farrington, Consulting Engineer of Syracuse.

Mr. Herbert A. Rice, Assoc. M. Am. Soc. C. E., has resigned as Instructor in Civil Engineering in Lehigh University to accept an Assistant Professorship of Civil Engineering in the University of Kansas. Mr. Rice was graduated from the University of Ohio with the degree of Civil Engineer in 1897. He then taught mathematics for two years in the High School at Jackson, O., and later was engaged in engineering work. He designed and built the Portland Cement Mill at Ironton, O. Mr. Rice came to Lehigh in 1902 and for the past year has been the senior Instructor in the Department of Civil Engineering.

Mr. Eugene Lentilhon, Assoc. M. Am. Soc. C. E., since 1897 a contracting engineer in New York City, has become associated with J. G. White & Co., and is now on his way to Chili on a mission covering the investigation of a number of important engineering projects. Mr. Lentilhon is a graduate of the Sheffield Scientific School of Yale University, and, for several years following his graduation, was in the service of the Dock Department of New York City. His most important work in this direction was his supervision as Assistant Engineer of improvements and repairs on the North River from Battery to 14th Street.

Capt. Eugene W. Van C. Lucas, M. Am. Soc. C. E., has resigned his commission in the Corps of Engineers, U. S. Army, the resignation to take effect Jan. 1, 1906. Captain Lucas is a graduate of U. S. Military Academy, and after serving in the Artillery for a time, in [illegible], 1888, he was transferred to the Engineer Corps. [illegible] Oct. 31, 1902, he has been stationed at Memphis, in charge of the First District of the Mississippi [illegible] for the purpose of improvement and the construct[illegible] repair of levees. He is a member of the Board of [illegible] neer' Officers on building and repair of levees [illegible] Mississippi River, and is also Engineer 16th Light [illegible] District.

Mr. George R. Wadsworth has resigned his [illegible] as Resident Engineer of the New York Central & [illegible] son River R. R., to accept a position on the [illegible] J. G. White & Co., as Assistant to the Const[illegible] Superintendent. Mr. Wadsworth was graduated [illegible] from the Civil Engineering Department of Mas[illegible] setts Institute of Technology and since that time [illegible] been continuously employed on the N. Y. C. & [illegible] R. R., first being assigned to the office of the Di[illegible] Engineer at Albany, after which he worked in va[illegible] capacities, ultimately being appoited Assistant En[illegible]. After having performed several classes of work, Mr. Wadsworth was appointed Resident Engineer of the Hud[illegible] son District in charge of the contract work from [illegible] haven to Croton and it is this position which he [illegible] to join the J. G. White & Co. forces.

Mr. M. C. Byers, Engineer of Maintenance of Way of the St. Louis & San Francisco R. R., with headquarters at Cape Girardeau, Mo., has been transferred to St. Louis, Mo., and has been assigned to special duties in connection with Maintenance of Way Work. The office of Engineer Maintenance of Way, Third District, has been abolished and the jurisdiction of Mr. C. D. Purdon, Engineer Maintenance of Way, has been extended to cover that district. In addition the office of division engineer on all districts has been abolished and four residencys organized, three of which will be in charge of resident engineers. Appointments to these positions have been made as follows: Mr. J. G. Taylor, heretofore Division Engineer, Western Division, Resident Engineer, with headquarters at Springfield, Mo.; Mr. C. B. Spencer, heretofore Division Engineer, Northern Division, Resident Engineer with headquarters at Joplin, Mo.; Mr. N. B. Hanna, Resident Engineer, with headquarters at Memphis, Tenn., and Mr. Herman Hall, Assistant Engineer, with headquarters at Cape Girardeau, Mo.

Obituary.

Franklin Hayes Davis, Superintendent of the Midvale Steel Co., of Philadelphia, died June 23 of heart disease, at Great Barrington, Mass., where he had gone for the benefit of his health. He was 35 years old.

Charles H. Ladomus, City Engineer of Chester, Pa., died, June 16, in that city, of nervous prostration and Bright's disease. He had been at the head of the City Engineering Department for a number of years.

George E. Mackin, General Manager of the Pressed Steel Car Co., of Pittsburg, Pa., who for the last two months had been ill at St. Joseph's Hospital, Philadelphia, with tuberculosis, died at that institution June 26.

C. C. Benschoten, former owner of the New Rochelle gas plant before it was merged into the Westchester Lighting Co., died June 25, at his home in White Plains, N. Y., aged 76. He built the first gas works in New Rochelle, N. Y., about 35 years ago.

C. E. Griffith, a civil engineer in charge of the erection of a cold storage and electrical plant at Panama, died recently at that place of yellow fever. He had done considerable engineering work in New York City, and went to Panama only about six months ago. He was 42 years old.

ENGINEERING SOCIETIES.

COMING MEETINGS.

SOCIETY FOR THE PROMOTION OF ENGINEERING EDUCATION.
June 28, 29, 1905. Annual meeting at Atlantic City, N. J. Secy., Prof. M. S. Ketchum, Boulder, Colo.

AMERICAN SOCIETY FOR TESTING MATERIALS.
June 29-July 1. Annual meeting at Atlantic City, N. J. Secy., Prof. Edgar Marburg, Philadelphia, Pa.

PACIFIC COAST ENGINEERING CONGRESS.
June 29 to July 1. At Portland, Oregon. Otto von Geldern, San Francisco, Cal., or Milnor Roberts, Seattle, Wash.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 29 to July 1. Annual convention at Portland, Oregon. Secy., Milnor Roberts, Seattle, Wash.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.
August 23 to 25, 1905. Annual convention at Erie, Pa. Secy., F. P. Foster, Corning, N. Y.

AMERICAN PUBLIC WORKS ASSOCIATION.
August 30, 31, 1905. Annual meeting at Chattanooga, Tenn. Secy., W. H. Flint, Chattanooga, Tenn.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting at Niagara Falls, N. Y. Secy., C. E. Jones, C., R. & Q. Ry., Reardstown, Ill.

AMERICAN ELECTROCHEMICAL SOCIETY.
Sept. 18 to 20. Annual meetng at Bethlehem, Pa. Secy., S. S. Sadtler, 39 S. 10th St., Philadelphia, Pa.